

8.0 LESSONS LEARNED

8.1 NRC Information Notices

August 30, 1989

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE NO. 89-61: FAILURE OF BORG-WARNER GATE VALVES TO CLOSE AGAINST DIFFERENTIAL PRESSURE

Purpose

This information notice is intended to alert addressees to potential problems resulting from Borg-Warner gate valves with air or motor actuators failing to close against differential pressures. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On March 14, 1988, a motor-driven auxiliary feedwater (AFW) pump discharge isolation motor-operated valve (MOV) failed to fully close against a differential pressure of 1800 psi at Catawba Nuclear Power Plant, Unit 2. The valve failed while an AFW piping flush was being performed. At the time of the failure, the reactor was shut down and the steam generators were in hot standby. The failure of the MOV to fully close was a contributing factor that led to overfilling steam generator 2A and resulted in an automatic feedwater isolation. The licensee, Duke Power Company, investigated the failure and reported (Licensee Event Report No. 414/89-10) the cause to be a higher valve factor than originally specified by the valve manufacturer, Borg-Warner, for sizing valve actuators. The valve factor is the term which is multiplied by the valve seat area and the differential pressure across the valve to calculate one of the parameters used in the standard valve thrust formula. If a low valve factor is used when sizing the valve air or motor actuator, the calculated required valve thrust will also be low. This results in low torque switch settings being specified and, in some cases, can result in undersized air or motor actuators.

Discussion

The AFW MOV that failed to close against 1800 psi, 2CA62A, was a Borg-Warner 4-inch, 1500-psi, flexible wedge, carbon steel gate valve with a pinned body guide insert ring disk guide. Actuation of the torque switch stops the motor when the valve is closed and fully seated. The torque switch was not bypassed in the closing direction. Following the March 14, 1988, failure to close, the valve was diagnostically tested and the switch settings were found to be within specified tolerances. Since no problems were found with the torque switch settings, the valve was retested at 1800 psi differential pressure and again failed to fully close. In order to get the valve to fully close at 1800 psi differential pressure, the closed torque switch setting had to be increased to the maximum allowed by the manufacturer's design calculations.

During the subsequent refueling outage, the valve was disassembled and inspected by the licensee in order to determine what was creating the excessive friction between the disk and seat rings. The inspection did not reveal any damage or conditions that would have caused excessive friction.

In November 1988, Duke Power Company performed differential pressure testing on an MOV identical in design to 2CA62A. This testing was performed on a test loop at the Riverbend Steam Station. During the testing, valve signature analysis was obtained. This testing resulted in higher than anticipated seating loads at high differential pressure conditions, and the valve failed to close on two of the tests completed with differential pressures greater than 1500 psi.

In November 1988, four Catawba Nuclear Power Plant Unit 1 AFW MOVs, identical in design and size to 2CA62A, were differential pressure tested at 1800 psi. All four valves indicated intermediate position after being closed during the test and were 1/8 inch to 1/2 inch from the fully closed position. The test results identified that all four valves failed to wedge completely shut. One valve did not close enough to shut off flow.

In March 1989, valve 2CA62A and three identical Unit 2 AFW MOVs were differential pressure tested at 1800 psi. During the test, the three Unit 2 identical valves failed to completely close and isolate flow. All four valves failed to wedge completely shut. Valve signature analysis test data obtained during this testing yielded closing valve factors ranging from 0.38 to 0.74 and were different for each valve tested. These were higher than the 0.3 valve factor utilized by the valve manufacturer to size the actuators.

Testing performed by Duke Power Company on carbon steel valves similar in design to 2CA62A has yielded opening valve factors ranging from 0.48 to 0.67.

Testing performed by Duke Power Company on stainless steel valves similar to 2CA62A has yielded valve factors ranging from slightly higher than 0.3 to 0.5.

Based on Duke Power Company testing, the valve factor of 0.3 originally utilized for Borg-Warner flexible wedge carbon steel or stainless steel gate valves with pinned body guide insert rings when sizing air or motor actuators was not correct. The actual valve factors, as measured by Duke Power Company, vary from valve to valve but are consistently above 0.3. This results in the potential that air- or motor-actuated valves will not operate against a differential pressure when called upon to do so because of inadequate torque switch settings or undersized actuators.

Related Generic Communications

The general concern of the ability of motor-operated valves to function properly when subjected to the design basis loadings has been previously addressed in NRC Bulletins 81-02, "Failure of Gate Type Valves to Close Against Differential Pressure," and 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings;" Circular 77-01, "Malfunctions of Limitorque Valve Operators;" Information Notices 81-31, "Failure of Safety Injection Valves to Operate Against Differential Pressure," and 85-50, "Complete Loss of Main and Auxiliary Feedwater at a PWR Designed by Babcock & Wilcox;" and Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance."

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate NRR project manager.

Charles E. Rossi, Director

Division of Operational Events Assessment

Office of Nuclear Reactor Regulation

Technical Contact:

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December 26, 1989

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE NO. 89-88: RECENT NRC-SPONSORED TESTING OF MOTOR-OPERATED VALVES

Purpose

This information notice is intended to alert addressees to potential problems identified as a result of recent NRC-sponsored testing of motor-operated valves (MOVs). It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

The NRC-sponsored blowdown testing of six motor-operated, flexible wedge gate valves was recently completed. The test results are generally applicable to any MOV that must open or close in a high flow, a high differential pressure, or a low subcooling situation.

The tests were sponsored by the NRC and conducted by the Idaho National Engineering Laboratory (INEL) at the Kraftwerk Union (KWU) facility in the Federal Republic of Germany. The test results substantiated and expanded the concerns that were previously identified with the operational capability of MOVs in high flow, high differential, or low subcooling applications.

These previous concerns were identified by INEL testing of two MOVs at the Wyle Labs facility in Huntsville, Alabama, and were reported in NUREG/CR-5406, "BWR Reactor Water Cleanup System Flexible Wedge Gate Isolation Valve Qualification and High Energy Flow Interruption Test." The expanded concerns now include (1) valves supplied by four different manufacturers; (2) valves of two different sizes (i.e., 6- and 10-inch valves); (3) water conditions, including several different subcoolings and pressures; and (4) saturated steam conditions at several different pressures.

Using experience gained from the Wyle tests, INEL adjusted the torque switches to obtain higher stem thrust values than would have been required using the standard industry design formula. This was done to assure isolation of the vast majority of flow through each valve during each blowdown. However, these adjustments may have resulted in the stem thrust available during the blowdown tests being above that currently being used (and possibly also above the mechanical and electrical capabilities) for some currently installed valve and motor operator assemblies. Even with the high settings used during the KWU tests, several blowdowns resulted in closure of the flow area but did not achieve full seating of the valve. During one such test, there was considerable leakage through the valve after the valve stopped its closure stroke.

The KWU test results confirm the concern raised by the Wyle testing. The KWU test data has not been fully evaluated at this time, but preliminary review indicates that

1. 1. The valves required stem thrusts well in excess of those predicted by the industry design formula in use at the time of their design and manufacture.
2. 2. The required stem thrust of the valves was not linearly dependent on the differential pressure across the valve at the time of closure. This circumstance precludes determination of the required stem thrust from data that could be obtained under normal plant operating conditions.
2. 3. The thrust at which torque switch trip occurs was not constant with respect to the loading history of the valve. Many within the industry refer to this as the "rate of loading" phenomenon. However, the testing indicates that there may be more involved than variations of the torque switch spring pack's response time.
3. 4. The stem factor (i.e., the ratio of the motor operator's output torque to the valve's stem thrust) appears to be dependent on direction and magnitude of the load being applied to the stem.
4. 5. Several of the valves significantly damaged themselves during closure.

NRC plans to hold an information meeting to present the KWU test results for industry peer review. The meeting and a data report are planned for the early part of 1990.

Related Generic Communications

The general concern about the ability of MOVs to function properly when subjected to design-basis loadings has been previously addressed in NRC Bulletins 81-02, "Failure of Gate-Type Valves to Close Against Differential Pressure," and 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings"; NRC Circular 77-01, "Malfunctions of Limitorque Valve Operators"; and NRC Information Notices 81-31, "Failure of Safety Injection Valves to Operate Against Differential Pressure," 85-50, "Complete Loss of Main and Auxiliary Feedwater at a PWR Designed by Babcock & Wilcox," and 89-61, "Failure of Borg-Warner Gate Valves to Close Against Differential Pressure."

In addition, Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," requested all addressees to develop a program for the testing, inspection, and maintenance of MOVs so as to provide the necessary assurance that the MOVs will function when subjected to the design-basis conditions that are to be considered during both normal operation and abnormal events in the design basis of the plant.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director

Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

June 5, 1990

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE NO. 90-40: RESULTS OF NRC-SPONSORED TESTING OF MOTOR-OPERATED VALVES

Purpose

This information notice is intended to provide addressees with specific information regarding the results of recent NRC-sponsored testing of motor-operated valves (MOV) which was discussed at a public meeting on April 18, 1990. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid problems with safety-related MOVs. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Background

The NRC Office of Nuclear Regulatory Research (RES) has been sponsoring an MOV testing program in support of the resolution of Generic Safety Issue 87 (GI-87), "Failure of HPCI Steam Line Without Isolation." The initial scope of GI-87 involved the evaluation of the capability of certain motor-operated flexible wedge gate containment isolation valves to mitigate the loss of reactor coolant inventory in the event of a pipe break outside of the containment building at boiling-water-reactor (BWR) plants. The particular MOVs involved in the GI-87 program were those in the turbine steam supply lines for the high pressure coolant injection (HPCI) and reactor core isolation cooling (RCIC) systems, and in the supply line to the reactor water cleanup (RWCU) system.

The MOV research is applicable to the programs established by licensees in response to Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." In that generic letter, the staff recommended that licensees and construction permit holders establish a program to provide for the testing, inspection, and maintenance of safety-related MOVs and certain other MOVs in safety-related systems. The purpose of this program is to provide assurance that the MOVs will function when subjected to design-basis differential pressure and flow conditions. As part of the generic letter program, the staff recommended that licensees and permit holders test the MOVs within the program in situ under design-basis conditions, where practicable. The schedule in the generic letter requested that the description of the MOV program be available within about a year of issuance of the generic letter and that the initial test program be completed in approximately five years. As a followup to the initial program, the staff recommended that the MOV switch settings and, thus, operability of the MOVs be reverified periodically.

Although the generic letter has a five-year schedule for completing the initial program, the staff indicated at the public workshops held to discuss the generic letter that the NRC regulations require that licensees act to resolve operability problems with specific MOVs when the problems are identified. As part of its review of the research results, the staff will consider the need to accelerate a portion or all of the Generic Letter 89-10 program for particular MOVs or systems.

In Generic Letter 89-10, the staff acknowledges that in situ testing of some MOVs within the generic letter program under design-basis conditions will not be practicable. At the generic letter workshops, the staff discussed several possible alternatives if such testing is not practicable, as well as potential problems and limitations associated with those alternatives. For instances in which testing of an MOV in situ under design-basis conditions is not practicable and the licensee cannot currently justify the use of an alternative to design-basis testing in situ, the staff has recommended the use of a “two-stage” approach: the licensee would set the MOV operating switches by means of the best data available and then would work to obtain applicable test data as soon as possible. The staff believes that applicable test data can be obtained within the five-year schedule. For the initial setting of the MOV switches under the two-stage approach, the test results obtained through the NRC research may constitute some of the best data available for the tested valves under a variety of fluid conditions.

Description of Circumstances:

The MOV testing program for GI-87 has been conducted in two phases by the Idaho National Engineering Laboratory (INEL). Phase I was performed in 1988 at the Wyle Laboratory facility in Huntsville, Alabama. The most significant tests in that phase consisted of opening and closing two 6-inch flexible wedge gate valves (manufactured by Anchor/Darling and Velan) under high differential pressure and high-temperature water conditions. The valves in Phase I of the research program were considered typical of those used for containment isolation in the supply line to the RWCU system. The results of the tested valves were discussed at a public meeting on February 1, 1989, and are documented in NUREG/CR-5406, “BWR Reactor Water Cleanup System Flexible Wedge Gate Isolation Valve Qualification and High Energy Flow Interruption Test.”

Phase II of the MOV test program was performed in 1989 at the Kraftwerk Union facility in the Federal Republic of Germany. This phase consisted of opening and closing three 6-inch flexible wedge gate valves (Anchor/Darling, Velan, and Walworth) and three 10-inch flexible wedge gate valves (Anchor/Darling, Powell, and Velan) against normal and blowdown (design-basis) flow conditions. The Phase II 6-inch and 10-inch valves were considered typical of those used for containment isolation in the supply line to the RWCU system and the turbine steam supply line of the HPCI systems, respectively. On December 26, 1989, the NRC staff issued Information Notice 89-88, “Recent NRC-Sponsored Testing of Motor-Operated Valves,” which alerted addressees to the tests and provided some preliminary results. On April 18, 1990, the NRC staff held a public meeting to discuss the results of Phase II of the MOV testing program. The test data are available in printed form in the NRC Public Document Room (Accession No. 9005170154). Magnetic tapes of the test data are available through the INEL Office of Technology Transfer.

The overall objectives of the MOV test program included the determination of the force required to

close the tested valves under various operating and design-basis fluid conditions through the measurement of stem thrust. Other program objectives were the determination of opening thrust requirements for the tested valves under different fluid conditions; evaluation of valve closure force components (such as disc friction and packing drag); measurement of the effects of temperature, pressure, and valve design on valve opening and closing loads; and evaluation of the valve thrust equation commonly used in the industry.

The tests for each MOV included cold leakage, cold and hot cycling, opening and closing under normal flow, closure under design-basis, and partial opening and closing under high differential pressure and flow conditions. Although the tested valves were intended to be typical of those used for containment isolation in the HPCI and RWCU systems of BWR plants, the results of the tests should be considered in terms of their applicability to all MOVs in nuclear power plants. A detailed analysis of the test data should be available in July 1990. Nevertheless, the NRC staff has begun to develop conclusions from the test data as a result of its review of the data and the discussions at the April 18, 1990, public meeting. Several preliminary conclusions are discussed below:

5. 6. Regardless of fluid conditions (i.e., steam, slightly subcooled water, or cold water), the tested valves required more thrust for opening and closing under various differential pressure and flow conditions than would have been predicted from standard industry calculations and typical friction factors. Thus, a potential exists for the underestimation of thrust requirements for valves in applications, and under fluid conditions, other than those of the valves involved in the NRC research. For the conduct of the tests, the motor operators for the valves were sized, and the torque switches were set, in an effort to ensure that each valve would fully stroke without regard to the thrust requirements predicted by the commonly used valve thrust equation. (Despite this effort, one valve failed to close completely during a blowdown test.) To provide an indication of the accuracy of the valve thrust equation, the thrust predicted by that equation for valve friction factors of both 0.3 and 0.5 was calculated during each test. Table 1 provides a summary of the blowdown tests and the minimum required thrust to close the tested valves. The table also indicates whether the valve thrust equation would have bounded the thrust requirement if valve friction factors of 0.3 or 0.5 had been used.

6. 7. Some of the tested valves sustained considerable internal damage during the blowdown tests. The occurrence of internal damage can cause the thrust required to operate a valve to exceed the thrust requirements predicted by the valve thrust equation. Such valves were referred to as "unpredictable" in the test program and included the 6-inch Anchor/Darling valve and the 10-inch Anchor/Darling, Powell, and Velan valves. In some instances, this increase in required thrust can be considerable and might exceed the capability of the motor or operator. Thrust requirements to close unpredictable valves under design-basis loads cannot be accurately determined without testing the valves (either individually or as prototypes) under those conditions.

7. 8. The research program revealed that the testing of a valve under static or low flow conditions cannot always be used to accurately predict the behavior of the valve under design-basis conditions by extrapolation. For example, the valves that were damaged during blowdown tests

operated normally under less severe flow tests. Thus, low-flow tests might not identify a valve that requires significantly more thrust than predicted by the valve thrust equation (i.e., a valve that is unpredictable).

8. 9. During opening of the valves, the maximum required thrust did not always occur at unseating. Rather, in certain instances, it occurred much later during the valve stroke. At nuclear plants, the staff has found that torque switches for MOVs are sometimes bypassed only during the initial portion of the opening stroke on the assumption that the thrust required to unseat the valve would be the maximum thrust for the full stroke. Thus, the research results raise a concern that the torque switches in some MOVs at nuclear plants might not be bypassed for a sufficient period of time during the opening stroke.

9. 10. For certain tests, the valve was closed from a partially open position. This partial stroking of the valve failed to predict the thrust requirements and to identify nonpredictable performance that were found during closure of the valve from a full open position. For example, during certain blowdown tests, valve damage began to occur before the valve was half closed. The accumulated damage over the full stroke influences the thrust required to close the valve.

10. 11. The research program revealed that measurements of torque, thrust, and motor operating data were needed to completely characterize MOV performance. For example, the measurement of torque or thrust alone cannot identify problems in the conversion of torque to thrust (i.e., abnormally large stem factors). Such problems can cause the thrust measured at normal or static conditions to be misleading as compared to the thrust that actually would be available under design-basis conditions. The measurement of motor operating characteristics allows the adequacy of the motor to be determined.

11. 12. The research program revealed that reliable information can be obtained from diagnostic analysis of MOVs only when operating data are collected by trained personnel using accurate and calibrated equipment. The MOV data must then be evaluated by individuals experienced in the performance of MOV diagnostic analysis.

The staff is continuing its review of the results of the MOV research. From this review, the staff may prepare additional information notices that discuss the staff's conclusions regarding the research. If an immediate safety problem is identified, the staff will initiate regulatory action to ensure the MOVs will perform their safety functions.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate NRR project manager.

Charles E. Rossi, Director

Division of Operational Events Assessment

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Attachments:

1. Table 1 - GI-87 Research Results for Blowdown Tests
2. List of Recently Issued NRC Information Notices

ATTACHMENT 1

TABLE 1. GI-87 RESEARCH RESULTS FOR BLOWDOWN TESTS

Manufacturer	D/P(psi)	T(F)	Fluid	Required Thrust(lbs)	Notes
SIX-INCH VALVES					
Anchor/Darling (Phase 1)	990	524	Hot water	20,000	(1)(2)
Anchor/Darling (Phase 2)	900	520	Hot water	>23,000	(1)(2)(3)
Velan (Phase 1)	990	524	Hot water	15,000	(4)
Velan (Phase 2)	950	520	Hot water	14,000	(2)
	1040	550	Steam	14,000	(4)
	750	<100	Cold water	13,000	(2)
	600	540	Hot water	9,000	(2)
	1000	470	Hot water	14,000	(2)
	1300	520	Hot water	16,000	(4)
Walworth	920	520	Hot water	9,000	(4)(5)(6)
	1100	550	Hot water	12,000	(4)(5)(6)
	1300	570	Hot water	15,000	(4)(5)(6)
TEN-INCH VALVES					
Anchor/Darling	750	510	Steam	29,000	(1)(2)
Powell	800	525	Steam	28,000	(1)(4)
	1040	550	Steam	29,000	(1)(4)
Velan	990	550	Steam	33,000	(1)(2)

1400	590	Steam	40,000	(1)(2)
1100	560	Steam	36,000	(1)(2)

NOTES:

1. Valve damage during stroke could result in higher thrust requirements than predicted by the valve thrust equation. (These valves are referred to as “unpredictable”).
 2. The valve thrust equation with valve friction factors of either 0.3 or 0.5 did not bound the required thrust in the blowdown test.
 3. The torque switch tripped before full valve closure.
 4. The valve thrust equation with a valve friction factor of 0.3 did not bound the required thrust in the blowdown test, but the equation did bound the required thrust if a valve friction factor of 0.5 was used.
 5. This valve had a removable guide which deformed during the blowdown test.
 6. In determining whether the MOV can accommodate the required thrust to close the valve, the weak link among the motor, operator, and valve must be identified. For the Walworth valve, this is especially important because stems with relatively small diameters are typically used in these valves.
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February 26, 1992

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 92-17: NRC INSPECTIONS OF PROGRAMS BEING DEVELOPED AT NUCLEAR POWER PLANTS IN RESPONSE TO GENERIC LETTER 89-10

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the general conclusions derived from the NRC inspections of the programs being developed at nuclear power plants in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In GL 89-10 (June 28, 1989), the NRC staff requested that holders of nuclear power plant operating licenses and construction permits ensure the capability of motor-operated valves (MOVs) in safety-related systems by reviewing MOV design bases, verifying MOV switch settings initially and periodically, testing MOVs under design basis conditions where practicable, improving evaluations of MOV failures and necessary corrective action, and determining trends of MOV problems. The NRC staff requested that licensees complete the GL 89-10 program by the end of the third refueling outage or 5 years from the issuance of the generic letter, whichever is later. On June 13, 1990, the NRC staff issued Supplement 1 to GL 89-10 to provide detailed information on the results of public workshops held to discuss the generic letter. On August 3, 1990, the NRC staff issued Supplement 2 to GL 89-10 to allow licensees additional time to review and to incorporate the information provided in Supplement 1 into their programs in response to the generic letter. Upon reviewing the results of NRC-sponsored MOV tests, the NRC staff issued Supplement 3 to GL 89-10 on October 25, 1990, which requested licensees of boiling water reactor (BWR) nuclear plants to take action in advance of the GL 89-10 schedule to resolve concerns about the capability of MOVs used for containment isolation in the steam supply line of the high pressure coolant injection and reactor core isolation cooling systems, in the supply line of the reactor water cleanup system, and in other systems directly connected to the reactor vessel. In Supplement 4 to GL 89-10, the NRC staff indicated that BWR licensees need not address inadvertent MOV operation in their GL 89-10 programs. The NRC staff is considering whether or not similar actions should be taken regarding the need for licensees of pressurized-water reactor (PWR) nuclear plants to address the inadvertent operation of MOVs in their programs to respond to GL 89-10.

Description of Circumstances

The NRC staff has conducted inspections at more than 30 nuclear power plant sites of programs being developed by licensees in response to GL 89-10. The reports of those inspections are available in the NRC Public Document Room. In performing the inspections, the NRC staff has followed Temporary Instruction (TI) 2515/109 of January 14, 1991, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance." Part 1 of TI 2515/109 provides guidance for reviewing the program being established by the licensee in response to GL 89-10, and Part 2 provides guidance for reviewing program implementation. The NRC has focused these inspections on reviewing the GL 89-10 programs (Part 1 of TI 2515/109). The staff is issuing this information notice to provide the more significant results of those NRC inspections.

In GL 89-10, the NRC staff requested that licensees prepare descriptions of their programs established in response to GL 89-10 within 1 year after the generic letter was issued or by the first refueling outage after December 28, 1989, whichever was later. The NRC staff's response to Question 44 in Supplement 1 to GL 89-10 provided guidance on information expected in the program descriptions. The NRC inspectors found some licensees to have program descriptions that are thorough while other licensees did not.

Attachment 1 is a discussion of the inspection findings pertaining to the recommendations of GL 89-10.

Related Generic Communications

In addition to NRC Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," and its supplements, the NRC has addressed this and related topics in NRC Information Notices 89-88, "Recent NRC-Sponsored Testing of Motor-Operated Valves;" 90-40, "Results of NRC-Sponsored Testing of Motor-Operated Valves;" 90-72, "Testing of Parallel Disc Gate Valves in Europe;" and 91-61, "Preliminary Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment."

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Charles E. Rossi, Director

Division of Operational Events Assessment

Office of Nuclear Reactor Regulation

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Attachments:

1. Inspection Findings Pertaining to the Recommendations Contained In Generic Letter 89-10

ATTACHMENT 1**INSPECTION FINDINGS PERTAINING TO THE RECOMMENDATIONS CONTAINED IN
GENERIC LETTER 89-10****Administration**

Some licensees have not ensured adequate management oversight and direction for the motor-operated valve (MOV) program. One licensee had contracted an internal audit that revealed problems with the MOV program similar to those found subsequently during the NRC inspection, but the licensee had not taken action to correct the deficiencies. The safety significance of the MOV program and the extensive resources needed to develop and implement the program make it imperative that licensee's management closely monitor its staff's activities.

Scope

In issuing Generic Letter (GL) 89-10, the NRC staff intended that the scope include all safety-related MOVs and other MOVs in safety-related systems. In Supplement 1 to GL 89-10, the NRC staff limited the scope of GL 89-10 to safety-related MOVs and other MOVs that are position-changeable in safety-related piping systems, as well as safety-related MOVs that might be in non-safety-related piping systems. The NRC staff's response to Questions 3–13 in Supplement 1 to GL 89-10 provided further guidance on the scope of GL 89-10. For example, in the NRC staff's response to Question 4 in Supplement 1, the staff defined "position-changeable" as any MOV in a safety-related piping system that is not blocked from inadvertent operation from the control room. In Supplement 4 to GL 89-10, the NRC staff indicated that licensees for boiling water reactor (BWR) plants need not address inadvertent MOV operation in their GL 89-10 programs. The NRC staff is considering whether or not similar actions should be taken regarding the need for the licensees of pressurized-water reactor (PWR) plants to address inadvertent MOV operation in their programs to respond to GL 89-10.

The NRC inspectors found most licensees to be establishing the scope of their GL 89-10 programs consistent with the recommendations of the generic letter. However, some licensees needed to improve the documentation of their justification for excluding particular MOVs from the GL 89-10 program.

Design-Basis Reviews

In recommended action "a" of GL 89-10, the NRC staff requested the licensees to review and document the design basis for operating each MOV within the generic letter program to determine the maximum differential pressure and flow (and other factors) expected for both normal operations and abnormal conditions. The NRC staff's response to Questions 14 to 18 and 36 in Supplement 1 to GL 89-10 provides guidance on performing design-basis reviews under GL 89-10.

Many licensees are appropriately reviewing plant documentation such as the final safety analysis report and the technical specifications as part of their design-basis reviews. However, some licensees had failed to identify worst-case conditions for various design-basis scenarios. Some licensees have assumed nominal reactor pressure for differential pressure across MOVs in lines directly connected to the reactor vessel without evaluating whether this differential pressure bounds the worst-case MOV design-basis

differential pressure. At certain facilities, the licensee found errors in the previous design basis determinations for many MOVs that would have affected the capability of the MOVs to perform their safety function if called upon under design-basis conditions.

Some licensees focused on differential pressure and had not adequately addressed other design-basis parameters such as flow, fluid temperature, ambient temperature, and the effects of seismic and dynamic events. Although differential pressure is the primary design-basis parameter used to predict the thrust requirements in the industry's equations, the other design-basis parameters are needed to ensure that the test results demonstrate that the MOV would operate under design-basis conditions. Some licensees have not ensured that generic studies of design-basis differential pressure apply to specific plants.

MOV Sizing and Switch Settings

In recommended action "b" of GL 89-10, the NRC staff requested licensees to review and revise, as necessary, the methods for selecting and setting all MOV switches. The NRC staff's response to Questions 19–21 in Supplement 1 to GL 89-10 provides guidance on selecting and setting MOV switches.

The recommendations of GL 89-10 for selecting and setting MOV switches apply to switches for torque, torque bypass, limit, and thermal overload. The licensees are using various methods to determine the proper size of MOVs and their appropriate torque switch settings. Some licensees have increased the valve factors assumed in the industry's equations used to predict the thrust required to operate the valves to reflect experience throughout the industry and at their specific plant. However, other licensees continue to use old guidance from valve vendors and manufacturers in estimating the thrust requirements that may be found inadequate during design-basis tests.

The NRC inspectors found that licensees for various facilities had not done the following when establishing methods to size MOVs and set their switches:

- (1) Provide justification for assumptions regarding stem friction coefficients and changes in stem friction over the lubrication interval
- (2) Consider effects that can reduce the thrust delivered by the motor operator under high differential pressure and flow conditions in relation to the thrust delivered under no-load conditions
- (3) Consider the effects of ambient temperature on motor output and thermal overload sizing
- (4) Demonstrate applicability of industry's databases in predicting thrust requirements
- (5) Consider inertia in establishing the maximum settings for torque switches
- (6) Demonstrate applicability of contractors' studies of actuator capability
- (7) Demonstrate applicability of generic motor curves for specific motors
- (8) Provide justification for removing conservatisms (such as the application factor) from the industry's standard sizing calculations

- (9) Consider torque switch repeatability
- (10) Consider uncertainties regarding the accuracy of MOV diagnostic equipment.

Some licensees have had problems in performing MOV sizing and switch setting calculations because of (1) incorrect spring packs installed in MOVs, (2) incorrect MOV data on the motor or actuator nameplates and in the procurement documents from the vendor, and (3) spring packs with different performance characteristics from different manufacturers, but with the same part number.

One licensee determined that the MOV sizing and switch setting activities to establish motor operator capability had not adequately addressed the effect of those activities on other MOV safety functions. These activities had hindered the ability of the clutch of certain MOVs to be released to enable the MOV to be manually operated in the event of an evacuation of the control room.

Many licensees are updating their degraded voltage studies to ensure that the worst-case minimum voltage available at the motor has been determined for each MOV. Some licensees had not ensured that their assumptions of minimum voltage available at the MOVs were consistent with their licensing commitments in safety analyses. Some licensees did not justify the assumptions for the starting point for the degraded voltage calculations, current used to calculate cable losses, losses caused by the resistance of thermal overload devices in the circuit, or the effects on MOV stroke time under degraded voltage conditions. Of particular significance, the inspectors found one licensee to be assuming an excessively small locked-rotor power factor (0.2) in the motor for use in the calculation of voltage drop from the motor control center to the MOV. The licensee's selection of this power factor was based on guidance in an Institute of Electrical and Electronics Engineers' standard that was not applicable to the size of motors typically used to operate valves in nuclear power plants. The assumption of an excessively small power factor causes an underestimation of the cable voltage drop and may result in the overestimation of MOV capability under design-basis conditions.

Licensees are improving their documentation of current and required MOV switch settings, but some weaknesses remain. For example, one licensee had simplified its control over changes to torque switch settings to expedite the process but, in so doing, caused the concern that the quality assurance department may not participate adequately in accepting those changes. Some of the weakness in documenting torque switch settings appears to result from the difficulty in reading the switches. Some licensees have raised torque switch settings for MOVs above the manufacturer's maximum specified value without performing an adequate safety analysis in accordance with the requirements of 10 CFR 50.59.

Design-Basis Differential Pressure and Flow Testing

In recommended action “c” of GL 89-10, the NRC staff requested licensees to test MOVs within the generic letter program in situ under their design-basis differential pressure and flow conditions. The NRC staff allows alternate methods to be used to demonstrate the capability of the MOV if testing in situ under those conditions is not practicable. The NRC staff suggested that the licensees follow a two-stage approach for a situation in which design-basis testing in situ demonstrating MOV capability. In performing the two-stage approach, a licensee would evaluate the capability of the MOV using the best data available and then would obtain applicable test data within the schedule of the generic letter. The NRC staff’s response to Questions 22–32 and 37 in Supplement 1 to GL 89-10 provides guidance on design-basis testing and the two-stage approach.

Many licensees have is not practicable and the licensees could not justify an alternate method of committed to test MOVs within the scope of their GL 89-10 program under design-basis conditions, where practicable. Some licensees have indicated that most MOVs can be tested at or near design-basis conditions. Other licensees (primarily those of BWR plants) estimate that a much smaller percentage of MOVs can be tested at or near design-basis conditions. These licensees have not thoroughly evaluated the ability to conduct MOV tests under design-basis or maximum achievable conditions.

Licensees who have begun differential pressure and flow testing have found some MOVs to require more thrust to operate than predicted by the industry’s standard equation with typical valve factors (such as 0.3 for flexible wedge gate valves) assumed in the past. For example, the Alabama Power Company, the licensee of the Joseph M. Farley Nuclear Plant, found less than half of the 55 flexible wedge gate valves tested under differential pressure and flow conditions to have their thrust requirements bounded by the industry’s standard equation with a 0.3 valve factor. The industry’s test results confirm the conclusions of NRC-sponsored MOV research that the industry’s past methods of determining the size of MOVs and setting their torque switches were inadequate for some MOVs.

The NRC staff has found weaknesses in the licensees’ procedures for conducting the differential pressure and flow tests, the acceptance criteria for the tests in evaluating the capability of the MOV to perform its safety function under design-basis conditions, and the process for incorporating the test results into the methodology used by the licensee in predicting MOV thrust requirements. The NRC regulations and the plant’s technical specifications (TS) establish requirements for licensees’ actions and reporting when safety-related equipment is determined to be, or has been, unable to perform its safety functions. Some licensees did not appear aware of their obligations to address MOV operability following testing performed under their programs established in response to GL 89-10. For example, some licensees have not been evaluating the results of MOV tests to verify the capability of the tested MOVs to perform their safety functions under design-basis conditions and to evaluate the adequacy of their methodology to size and set other MOVs. Some licensees appeared to discard test data as suspect without careful evaluation. The NRC staff has also found a lack of coordination among licensees in disseminating and using MOV test data. For example, some licensees are not considering tests conducted by other licensees which might reflect on the adequacy of their assumptions in predicting thrust requirements.

For MOVs that cannot be tested under design-basis differential pressure and flow conditions, the NRC

inspectors have found that some licensees are not following their commitments to the two-stage approach (discussed in Supplement 1 to GL 89-10) to test those MOVs at the maximum differential pressure and flow achievable. If the test pressure and flow are near to the design-basis conditions, the licensee may be able to justify extrapolating from the test results to demonstrate the capability of the MOV to perform its safety function under design-basis conditions. Where the MOV cannot be tested near design-basis conditions, the licensee can use the results of the test at maximum achievable conditions to help confirm valve factor assumptions in its sizing and switch setting methodology and to set the MOV using the best available data. The licensee may also find TS actions and reporting requirements that take effect as a result of tests of MOVs at less than full design-basis differential pressure and flow conditions if those tests reveal that the MOVs could not perform their safety functions under design-basis conditions.

Testing MOVs at maximum achievable conditions is especially helpful in establishing a plant-specific database if the licensee estimates that only a small percentage of MOVs can be tested at or near design-basis conditions.

Some licensees who, in their initial response to GL 89-10, committed to implement the recommendations of GL 89-10 to test MOVs where practicable have indicated an interest in grouping certain MOVs to reduce the amount of testing (although testing of those MOVs would be practicable). Item 1. of GL 89-10 states that licensees shall submit any changes to scheduled commitments, and that revised schedules or alternative actions may be implemented without NRC approval with justification retained on site.

In their initial responses to GL 89-10, some licensees stated that they would attempt to group MOVs to limit the extent of design-basis testing. The preliminary results of design-basis tests at several plants (for example, Catawba, Farley, Oconee and Surry) indicated that apparently identical MOVs performed significantly different under high differential pressure and flow conditions. This could cause difficulty in grouping MOVs in such a manner that a small sample of MOV tests can be used to demonstrate that all MOVs can perform their safety functions under design-basis conditions.

The motor operators for most gate valves are set to close on torque to provide adequate leakage control. Licensees are attempting to develop a method to ensure that MOVs closed using the limit switch meet the requisite leakage limitations in safety analyses without causing an MOV overstress condition.

Periodic Verification of MOV Capability

In recommended action “d” of GL 89-10, the NRC staff requested that licensees prepare or revise procedures to ensure that adequate MOV switch settings are determined and maintained throughout the life of the plant. In paragraph “j” of GL 89-10, the NRC staff recommended that the surveillance interval be based on (1) the safety importance and (2) the maintenance and performance history of the MOV, but that the interval not exceed 5 years or 3 refueling outages, whichever is later. Further, the staff stated that the capability of the MOV should be verified if the MOV is replaced, modified, or overhauled to an extent that the existing test results do not represent the MOV. The NRC staff’s response to Questions 33–35 and 38 in Supplement 1 to GL 89-10 provides guidance on periodically verifying MOV switches and performing tests after completing maintenance.

The recommendation of GL 89-10 for verifying periodically the adequacy of MOV switch settings includes torque, torque bypass, limit, and thermal overloads. Many licensees have stated that they will attempt to use tests of MOVs with diagnostic equipment under zero differential pressure and flow conditions (static conditions) to demonstrate the adequacy of torque switch settings and the continued capability of MOVs to perform their safety functions under design-basis conditions. However, to date, none of those licensees have provided justification for applying the results of tests conducted under static conditions to demonstrate design-basis capability. These licensees appear to be waiting on yet to be developed generic justification for static or low differential pressure and flow testing.

At least one licensee indicated an intent to clean and lubricate the valve stem before performing periodic verification testing. This would be inconsistent with demonstrating that the MOV had been set adequately and was capable of performing its function at the end of the test interval.

In GL 89-10, the NRC staff stated that testing at design-basis conditions need not be repeated unless the MOV is replaced, modified, or overhauled to the extent that the licensee considers that the existing test results are not representative of the MOV in its modified configuration. Many licensees are improving their methods to demonstrate that the MOVs are capable of performing their safety functions under design-basis conditions following maintenance.

MOV Failures, Corrective Actions, and Trending

In recommended action “h” of GL 89-10, the NRC staff requested that licensees analyze or justify each MOV failure and corrective action. The staff also requested that the documentation include the results and history of each as-found deteriorated condition, malfunction, test, inspection, analysis, repair, or alteration. The staff noted that the licensee must retain and report all documentation in accordance with the plant’s requirements. The staff also suggested that the material be examined every 2 years or after each refueling outage after the program is implemented as part of the monitoring and feedback effort to establish trends of MOV operability. These trends could provide the basis on which the licensee can revise the testing frequency established to verify periodically that the MOV has adequate capability. The NRC staff indicated that the system should be well-structured and should track, capture, and share history data on individual components. The NRC staff’s response to Questions 39 and 40 in Supplement 1 to GL 89-10 provides guidance on identifying trends of MOV problems.

The NRC inspectors have found some licensees to have weaknesses in evaluating MOV failures and deficiencies (such as the operability effects of spring pack relaxation). Some licensees have not been thorough in performing root cause analyses of MOV problems. Most licensees are attempting to improve their methods for identifying trends in MOV problems.

Schedule

In GL 89-10, the NRC staff requested that, by June 28, 1994, or by the third refueling outage after December 28, 1989, whichever is later, licensees complete all design-basis reviews, analyses, verifications, tests, and inspections that were initiated in order to satisfy the actions recommended in the generic letter. The NRC staff’s response to Question 41 in Supplement 1 to GL 89-10 provides guidance on the schedule for implementing these actions specified in GL 89-10.

Some licensees have not made adequate progress for resolving the MOV issue for their facilities within the recommended schedule of GL 89-10. The findings of licensees as they begin to initiate their programs in response to GL 89-10 and the results of the NRC inspections of GL 89-10 programs reinforce the importance of promptly resolving this safety-significant issue. The NRC staff has accepted limited extensions of the GL 89-10 schedule for particular licensees who have provided justification.

March 27, 1992

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors and All Vendors of Motor-Operated Valve (MOV) Diagnostic Equipment

Subject: NRC INFORMATION NOTICE 92-23: RESULTS OF VALIDATION TESTING OF MOTOR-OPERATED VALVE DIAGNOSTIC EQUIPMENT

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the final results of validation testing of MOV diagnostic equipment conducted for the MOV Users Group (MUG) of nuclear power plant licensees. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In 1990, the MUG initiated a program to conduct tests of MOV diagnostic equipment to validate the accuracy asserted by the equipment vendors. The MUG requested the Idaho National Engineering Laboratory (INEL) to provide a test stand for the program. The NRC Office of Nuclear Regulatory Research (RES) provided funds for INEL to participate, with the stipulation that the results of the testing would be made available to the NRC and the public. The MOV diagnostic equipment vendors participating in the MUG test program were ASEA-Brown Boveri (ABB) Impell, ITI-MOVATS, Liberty Technologies, Siemens/KWU, Teledyne, and Wyle Laboratories. The INEL test stand included a Limatorque motor operator which pushes a valve stem into a water reservoir with a compressed air overcharge, providing various loading conditions on the valve stem. INEL obtained accurate measurements of thrust using a stem-mounted load cell as a reference standard. Each diagnostic equipment vendor installed and operated its own equipment to measure various parameters so as to obtain estimates of stem thrust.

At a public meeting on July 30, 1991, the MUG released a progress report of its program to validate the accuracy of MOV diagnostic equipment. During the meeting, the MUG stated that licensees and diagnostic equipment vendors should review the progress report for its applicability to MOVs installed in nuclear power plants. The MUG also alerted licensees and diagnostic equipment vendors to their responsibilities under Part 21 of Title 10 of the Code of Federal Regulations (10 CFR Part 21). The NRC issued Information Notice 91-61 (September 30, 1991), "Preliminary Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment," to alert licensees to the issues raised by the MUG progress report.

Description of Circumstances

At a public meeting on February 3, 1992, the MUG released "Final Report - MUG Validation Testing as Performed at Idaho National Engineering Laboratories (Volume 1)." The report has been placed in the NRC Public Document Room (PDR), 2120 L Street, N.W., Washington, D.C. 20555 (telephone (202) 634-3273). Upon receiving the remaining three volumes, which will provide data traces, test documentation, and torque measurement information, the staff will place these volumes in the PDR. On March 4, 1992, the NRC staff discussed the MUG final report with members of the MUG committee that conducted the validation program. The MUG final report presents the findings of the validation program and specifies whether or not the tested diagnostic equipment provided the accuracy claimed by its vendors in predicting stem thrust. The MUG final report indicates that the MOV diagnostic equipment that relied on spring pack displacement to estimate stem thrust did not meet the accuracy claims of its vendors. MOV diagnostic equipment that relied on other parameters such as stem or yoke strain was shown, in general, to meet the applicable accuracy claims, although certain equipment did not meet the accuracy claims in certain individual tests.

ABB Impell and ITI-MOVATS are two MOV diagnostic equipment vendors that have equipment commercially available that relies on spring pack displacement to estimate stem thrust. At the MUG meeting in February 1992, ABB Impell representatives stated that they would work with their two licensee customers to develop new accuracy values. On March 2, 1992, the NRC staff held a public meeting with representatives of ITI-MOVATS to discuss the accuracy of the thrust measuring device (TMD) used by ITI-MOVATS to estimate stem thrust based on spring pack displacement. During the meeting on March 2, the representatives of ITI-MOVATS described the results of their own field validation program that had been initiated to address the preliminary concerns raised in the MUG progress report. However, the ITI-MOVATS program addressed only the accuracy of the TMD under static (zero differential pressure and flow) conditions and not the accuracy of this equipment under differential pressure and flow conditions. Nevertheless, the results of the field validation program showed that the inaccuracy of the TMD may be larger than assumed in some instances by licensees. The ITI-MOVATS representatives also discussed the results of their efforts to resolve concerns regarding the fact that the TMD is calibrated in the valve opening direction, but is also used to predict the thrust delivered by the actuator in the valve closing direction. Although this study of valve directional effect by ITI-MOVATS focused on static conditions, the study indicated that the effect of the direction that the valve moves could increase significantly the uncertainty of the TMD.

Discussion

Many licensees rely on MOV diagnostic equipment to provide information on the thrust required to open or close the valve and on the thrust delivered by the motor actuator. The various types of MOV diagnostic equipment estimate valve stem thrust using different parameters, such as the displacement of the spring pack or the strain in the stem, mounting bolts, or yoke. Some licensees make decisions regarding the operability of safety-related MOVs based on the thrust information obtained from the diagnostic equipment. Therefore, the use of MOV diagnostic equipment can affect significantly the safe operation of a nuclear power plant.

The MUG validation program indicated that the accuracy of MOV diagnostic equipment that relies on spring pack displacement has not been verified to be within its original stated accuracy under differential pressure and flow conditions. Further, the field validation program and valve directional effect study by ITI-MOVATS have shown an increase in the uncertainty of this MOV diagnostic equipment under static conditions. Therefore, licensees who use MOV diagnostic equipment that relies on spring pack displacement to make decisions regarding the capability of MOVs to operate under design-basis conditions may have overestimated the capability of those MOVs. A particular concern arises where a licensee has lowered the torque switch settings of its MOVs below the settings recommended by the actuator manufacturer based on thrust estimates from diagnostic equipment during tests conducted under static or partial design-basis differential pressure conditions.

The NRC will address each case individually for MOV diagnostic equipment that was not included in the MUG validation program. For example, the concerns regarding the accuracy of MOV diagnostic equipment that relies on spring pack displacement apply to all commercial or plant-specific MOV diagnostic equipment that relies on spring pack displacement to estimate stem thrust. Similar concerns might be present for other MOV diagnostic equipment that also predicts stem thrust by indirect means, such as spring pack force.

“Load-sensitive behavior” in an MOV has been shown to result in less thrust delivered by the actuator under differential pressure conditions than delivered under static conditions. “Load-sensitive behavior” is independent of the type of MOV diagnostic equipment used and such behavior can lead licensees to overestimate the capability of their MOVs.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Charles E. Rossi, Director

Division of Operational Events Assessment

Office of Nuclear Reactor Regulation

November 2, 1992

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 92-59, REVISION 1: HORIZONTALLY-INSTALLED MOTOR-OPERATED GATE VALVES

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this revision to Information Notice (IN) 92-59, "Horizontally-Installed Motor-Operated Gate Valves," to clarify the problems with the performance of motor-operated gate valves that are installed in a horizontal position. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

This revision, which supersedes the original IN 92-59, repeats the original Description of Circumstances and Discussion with the following revisions in the second paragraph of the Discussion.

In the original notice, the NRC staff alerted addressees to problems with the performance of motor-operated valves (MOVs) that are installed with their gate valves in a horizontal orientation. This orientation may result in the actuator spring pack, motor, or the limit switch compartment being the lowest point of the MOV. In the original notice, the staff discussed problems that could result from the actuator spring pack or motor being the lowest point of an MOV. This revision was written to point out that installing an MOV with the limit switch compartment as the lowest point also increases the possibility for grease to leak into the compartment and affects MOV operation and maintenance.

Description of Circumstances

Three licensees recently informed the NRC staff that they had problems testing motor-operated valves (MOVs) that had been installed with the valve disc oriented horizontally.

On March 13, 1992, the Southern California Edison Company, licensee for the San Onofre Nuclear Generating Station, informed the NRC that two of four 4-inch gate MOVs in the high pressure coolant injection/low pressure coolant injection (HPCI/LPCI) combined miniflow line at Unit 3 failed to close during design-basis differential pressure and flow testing performed in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." The licensee adjusted the MOVs in the Unit 3 miniflow line to satisfy the thrust requirements demonstrated by the tests. Before testing the Unit 3 MOVs, the licensee had added new spring packs and provided higher gear ratios in these MOVs as part of its GL 89-10 program. However, the licensee did not modify the motor operators for the Unit 2 HPCI/LPCI miniflow MOVs, which remained sized and setup under the old assumptions of the licensee's program in response to NRC Bulletin 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings." Therefore, the licensee shut down Unit 2 as a safety precaution because of the concern that the Unit 2 miniflow MOVs would not be able to

perform their safety function. The licensee then improved the Unit 2 miniflow MOVs with new spring packs and higher gear ratios to allow the MOVs to satisfy the higher thrust requirements. The licensee tested the improved Unit 2 miniflow valves under design-basis differential pressure and flow conditions, and they performed satisfactorily. The licensee evaluated the Unit 2 test data and determined that its decision to shut down Unit 2 was appropriate because the test results revealed that the Unit 2 miniflow MOVs could not have operated in their old configuration under design-basis conditions. The licensee believed that the higher thrust requirements for these MOVs resulted from their horizontal orientation, which caused additional sliding friction on the valve discs.

During a midcycle outage in October 1991 at the Crystal River Plant, the Florida Power Corporation, the licensee, tested emergency feedwater (EFW) MOV EFV-14 from EFW pump EFP-1 to the "A" steam generator under differential pressure and flow conditions as part of its program in response to GL 89-10. During the test, the valve did not close electrically under the design-basis differential pressure conditions calculated by the Babcock & Wilcox Company (B&W) for Crystal River. The EFW system at Crystal River has four discharge isolation valves, one in each of the EFW supply lines to the once-through steam generators (OTSGs). The MOVs are required to close during a high-energy line break to isolate flow to the damaged OTSG thereby only supplying the undamaged OTSG. At that time, the licensee believed that the differential pressure calculated for EFV-14 by B&W was greater than the actual design-basis differential pressure. On April 28, 1992, the licensee notified the NRC staff that it had determined that the differential pressure calculated for EFV-14 was actually greater than the value calculated by B&W. Thus, the October 1991 test failure had properly revealed that EFV-14 could not perform its safety function to close under design-basis differential pressure. In its April 28 notification, the licensee indicated that it had closed EFV-14 and the parallel EFV-11 from EFP-2 to the "A" steam generator because of its similar design to EFV-14. The licensee reviewed the results of previous testing and concluded that the EFW control logic could open these MOVs if needed. Before the failed test, the licensee had set EFV-14 using assumptions more conservative than those of some other licensees, but EFV-14 nevertheless failed to operate under design-basis differential pressure conditions. After April 28, the licensee conducted differential pressure tests on the other three EFW MOVs (including EFV-11) and found those MOVs also to be incapable of closing under design-basis differential pressure and flow. All four of these MOVs are installed horizontally. The licensee attributed the failure of the EFW MOVs to their horizontal orientation. The licensee has modified the four EFW MOVs and successfully tested them under design-basis differential pressure conditions.

On April 14, 1992, the Power Authority of the State of New York, the licensee of the James A. FitzPatrick Nuclear Power Plant, notified the NRC staff that the double disc gate valves 10 MOV-16A and 10 MOV-16B in residual heat removal/low pressure coolant injection pump minimum flow lines might not be able to fully seat during closure because they do not include wedge springs. After conducting MOV tests, the licensee had noted unusual valve behavior reviewing diagnostic traces and requested the valve manufacturer, Anchor/Darling to explain the behavior of these valves. Anchor/Darling informed the licensee that it did not include "wedge springs" and "disc retainers" in its double disc gate valves manufactured before 1975 (such as 10 MOV-16A&B) when it believed that the valves were to be installed with the valve stem vertical and pointing upward. The wedge spring allows the

valve to be installed in any orientation by maintaining separation of the discs and preventing wedging before the disc contacts the valve seat. The disc retainers improve performance during valve closure by limiting disc wobble.

Because 10 MOV-16A and 10 MOV-16B are installed horizontally, the licensee determined that premature wedging could prevent these valves from closing when required for containment isolation. The licensee has installed wedge springs in the valves to correct the problem.

Discussion

Many nuclear power plant licensees have begun testing MOVs as part of their programs in response to GL 89-10. Some licensees have found that the thrust required to operate MOVs under differential pressure and flow conditions is greater than predicted by the valve vendor using the industry's standard equations and valve factors. Some licensees have believed that the higher thrust would be required only under blowdown conditions. However, licensees have found more thrust than predicted is required to operate some MOVs under pumped flow conditions. Although higher-than-predicted thrust requirements have been observed for MOVs in various installed orientations, MOVs in horizontal positions may be especially susceptible to performance problems, including higher thrust requirements. Installing an MOV in a horizontal orientation can also lead to maintenance and performance problems other than those caused by the friction or binding of the disc. For example, the actuator spring pack, motor, or limit switch compartment might be at the lowest point of an MOV. If the spring pack is at the lowest point, excessive grease in the spring pack might cause hydraulic lock, which would prevent the torque switch from tripping and might overstress the MOV or cause the motor to burn out. If the motor is at the lowest point, the gasket between the motor and actuator might allow grease to fill the motor and cause it to fail. If the limit switch compartment is at the lowest point, grease leaking into the compartment from the gear case may affect MOV operation or increase the difficulty of maintenance.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

ORIGINAL SIGNED BY

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

January 4, 1993

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 93-01: ACCURACY OF MOTOR-OPERATED VALVE DIAGNOSTIC EQUIPMENT MANUFACTURED BY LIBERTY TECHNOLOGIES

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to new information on the accuracy of motor-operated valve (MOV) diagnostic equipment manufactured by Liberty Technologies when used to estimate the thrust delivered by a motor actuator in opening or closing its valve. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

Most licensees rely on MOV diagnostic equipment to provide information on the thrust delivered by the motor actuator in opening or closing its valve. The various types of MOV diagnostic equipment estimate valve stem thrust using different parameters, such as displacement of the spring pack or strain in the stem, mounting bolts, or yoke. Liberty Technologies has developed MOV diagnostic equipment, referred to as the Valve Operation Test and Evaluation System (VOTES), that estimates the thrust needed to open or close a valve based on strain of the valve yoke. The VOTES equipment derives thrust from yoke strain that has been calibrated to stem thrust using measured diametral strain of the valve stem and nominal engineering material properties.

Many licensees make decisions regarding the operability of safety-related MOVs that are based on diagnostic equipment thrust readings. Therefore, the use of MOV diagnostic equipment can have a significant effect on the safe operation of a nuclear power plant.

Description of Circumstances

On October 2, 1992, Liberty Technologies notified the NRC, in accordance with Part 21 of the Title 10 of the Code of Federal Regulations, that it had determined that two new factors can affect the thrust values obtained with its equipment. Those factors involve (1) the possible use of improper stem material constants and (2) the failure to account for a torque effect when the VOTES equipment is calibrated by measuring strain in the threaded portion of the valve stem. In its October 2 submittal, Liberty Technologies states that the factors mainly cause the thrust estimated by its equipment to be less than the actual thrust. Therefore, the factors will primarily relate to the potential for the maximum allowable thrust limits of MOVs to be exceeded. In its October report, Liberty Technologies provided information on performing manual calculations to address these factors and stated that its new software, Version 2.3, assists in performing corrections to the thrust data.

During an inspection of the MOV program at the LaSalle Nuclear Power Station in November 1992 (NRC Inspection Report 50-373/92-023 dated December 16, 1992), the NRC found that the licensee had performed the manual corrections of thrust data from MOV tests in accordance with guidance provided by Liberty Technologies to address the stem material and torque effect issues. In certain instances, the licensee determined that the VOTES equipment had underestimated by as much as 40 percent the thrust delivered by the motor actuator in opening and closing its valve. This underestimation of actual thrust by the VOTES equipment raised questions regarding the effect of higher thrust on the MOV assembly and the operation of the motor under degraded voltage conditions for several MOVs.

Related Generic Communications

The NRC has issued other generic communications on the accuracy of MOV diagnostic equipment and thrust limits. Most recently,

- (1) On March 27, 1992, the NRC issued IN 92-23, "Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment," to alert licensees to information regarding the accuracy of MOV diagnostic equipment manufactured by ITI-MOVATS and ASEA-Brown Boveri Impell.
- (2) On December 17, 1992, the NRC issued IN 92-83, "Thrust Limits for Limitorque Actuators and Potential Overstressing of Motor-Operated Valves," to alert licensees to concerns identified in two programs used by licensees to increase thrust limits of Limitorque actuators.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

ORIGINAL SIGNED BY: Brian K. Grimes, Director
Division of Operating Reactor Support

June 9, 1993

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 93-42: FAILURE OF ANTI-ROTATION KEYS IN MOTOR-OPERATED VALVES MANUFACTURED BY VELAN

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential problems resulting from the failure of anti-rotation keys in motor-operated globe valves manufactured by Velan Valve Corporation. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On March 28, 1993, Wisconsin Public Service Corporation, the licensee for Kewaunee Nuclear Power Plant, reported that during motor-operated valve (MOV) dynamic testing on March 27, 1993, one of two redundant safety injection recirculation valves to the refueling water storage tank failed to close completely. Investigation revealed that the anti-rotation device, an L-shaped key between the valve stem and the yoke bushing (Attachment 1), had broken. The shorter part of the broken L-shaped key had apparently worked its way toward the valve stem and had jammed the valve stem, preventing closing. The valve that failed was a 2-inch bonnetless globe valve manufactured by Velan Valve Corp. The licensee inspected all nine similar motor-operated valves and found that six had broken anti-rotation keys. The inspections were visual and did not require disassembly of the motor-operated valve. Failures usually can be observed on normally closed valves, since the broken long leg of the L-shaped key slides down partially and becomes visible below the yoke bushing.

According to the licensee, the keys failed in a brittle manner. The fractures began on either side of the key at the sharp radius of the inside corner of the L-shaped key and propagated into the body of the key. Machining of the sharp inside corner of the L-shaped key may have contributed to the failure of the anti-rotation keys by producing high stresses in the corner of the keys. It is likely that the rotational action of the valve stem impacted on both sides of the key, exceeding the impact strength of the material at the sharp radius of the key.

In 1990, at the Maine Yankee Atomic Power Station, anti-rotation keys in 4-inch MOVs manufactured by Velan failed. Maine Yankee Atomic Power Company, the licensee, discovered that spare keys supplied by Velan for several of the valves were not of the proper hardness; they were Rockwell C-20 instead of the harder Rockwell C-59 as originally specified. Valves that may have had the wrong anti-rotation keys

installed were disassembled, and the licensee replaced the Rockwell C-20 keys with keys made of the correct material. The non-conforming keys that were removed showed signs of significant wear. During post-maintenance testing, several of the new (hardened) keys broke at the corner of the “L” shape. This happened because the keyway in the valve adaptor plate was too tight considering the service-related wear that had occurred to the rest of the keyway. Maine Yankee engineers specified that new larger keyways should be cut in the adaptor plate to prevent the key from breaking when the valve is actuated. The licensee repaired all the affected valves and then tested the valves to ensure that they operated satisfactorily.

Before testing MOVs at Prairie Island this past winter, an inspection of Velan globe valves also discovered anti-rotation key failures (2 broken keys found in 16 valves) in similar systems. Because of the location of the break on the anti-rotation key, and the length of the key and key slot, Northern States Power Company, the licensee, believed that the broken anti-rotation keys would still perform their intended function and that the broken piece (i.e., the short leg of the L-shaped key) would not interact with the valve stem so as to impede valve operation. This is at variance with the Kewaunee event discussed above. The licensee added a step to their generic actuator replacement procedure to inspect, clean, debur, and lubricate anti-rotation devices.

Discussion

On April 5, 1993, Velan issued the attached (Attachment 2) Service Bulletin #SB-106. This bulletin recommends that the anti-rotation keys be inspected for possible wear which could result in failure and that consideration be given to replacing the keys at the earliest convenient time. The replacement keys, which have been supplied by Velan for the past 2.5 years, are made of material meeting American Iron and Steel Institute (AISI) 4140 alloy steel, as opposed to 440C stainless steel (440C SS). AISI 4140 is significantly tougher than 440C SS. According to Velan, the material was changed to 4140 because 4140 is easier to procure and to heat treat properly. Velan plans to send this bulletin to all U.S. nuclear utilities. On the basis of conversations between the NRC staff and Velan subsequent to the issuance of the bulletin, and because of the hardness of anti-rotation keys made out of 440C SS, Velan suggests that both the keys and the keyways be inspected for damage and deterioration. The experience cited above indicates that the use of brittle material in anti-rotation keys can lead to failures, although valve operation may not always be impaired.

ORIGINAL SIGNED BY

Brian K. Grimes, Director

Division of Operating Reactor Support

Office of Nuclear Reactor Regulation

July 20, 1993

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 93-54: MOTOR-OPERATED VALVE ACTUATOR THRUST VARIATIONS MEASURED WITH A TORQUE THRUST CELL AND A STRAIN GAGE

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to a possible error in their diagnostic evaluation of motor-operated valve (MOV) actuators. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Diagnostic testing of MOVs is performed to satisfy the commitments made in response to NRC Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," and its supplements. Actuator output thrust is measured by a combination of transducers. The transducers include, but are not limited to, the ITI MOVATS torque thrust cell (thrust cell) and the Teledyne quick stem sensor (stem sensor).

On November 9, 1992, ITI MOVATS engineers working at the Turkey Point plant noticed that thrust measurements taken with the torque thrust cell were different from the stem-mounted strain gage readings after the thrust cell was removed. Review showed that all of the readings of the valves that had been tested using the stem sensor changed somewhat when the thrust cell was removed from the valve. Data indicated that thrust readings degraded by approximately 20 percent when the thrust cell was removed.

On November 10, 1992, ITI MOVATS management and a licensee engineer began to investigate the cause.

Discussion

As discussed above, to meet the commitments made in response to GL 89-10, most licensees rely on MOV diagnostic equipment to set the thrust delivered by the actuator in opening or closing its valve. Failure to properly account for inaccuracies introduced by the use of diagnostic equipment could result in either the MOV not being able to perform its intended safety function because of inadequate actuator output or the failure of a component in either the valve or the actuator because of excessive motor torque.

The devices discussed in the Description of Circumstances operate on the following principles:

-

- - The ITI MOVATS torque thrust cell is a radial web calibrated load cell. The inner ring of the cell is bolted to the top of the valve yoke and the outer ring to the bottom of the actuator. The rings are connected by eight webs that have strain gages to measure actuator torque and thrust simultaneously. Installation of the thrust cell requires that the actuator be raised a distance equal to the thickness of the thrust cell. This means that the actuator stem nut is in a new position on the valve stem.
 -
- - The Teledyne quick stem sensor is a strain gage mounted on a strip of foil with tabs on each end to facilitate installation on the valve stem. The sensor comes with leads preconnected to the gage. Epoxy is used to install the stem sensor on the valve stem.
 -
- - During the test, the valve is stroked and the thrust cell is used as a calibration reference for the stem sensor. Once the stem sensor is calibrated, it can be used for future MOV tests without using the thrust cell. The Limitorque actuator torque switch is then set to produce the required valve stem thrust. After the thrust cell is removed, a full valve stroke signature is obtained to evaluate overall actuator performance.

As a result of their review, ITI MOVATS and licensee personnel concluded that the most significant contributors to the observed changes in thrust when the thrust cell was removed are stem engagement and stem lubricant.

- - Stem engagements of less than one stem diameter tend to increase the thrust at torque switch trip by improving the stem factor. This effect is more pronounced when Neolube is used than when EP-O is used as a stem lubricant.
 -
- - Test results indicate that stroke-to-stroke variations in thrust at torque switch trip are greater with Neolube than with EP-O. For Neolube, the variations tend to be high on initial lubrication and then decrease as the valve is stroked.

In January 1993, ITI MOVATS engineers issued the attached report of their investigation of the discrepancies in thrust measurements which confirms that the primary causes are stem lubrication and stem nut wear.

Related Generic Communications

NRC has issued a number of information notices pertaining to the accuracy of MOV diagnostic equipment. Most recently, these have included NRC Information Notice (IN) 93-01, "Accuracy of Motor-Operated Valve Diagnostic Equipment Manufactured by Liberty Technologies;" IN 92-23, "Results of Validation Testing of Motor-Operated Diagnostic Equipment;" and IN 91-61, "Preliminary Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment."

NRC also issued Supplement 5 to GL 89-10, "Inaccuracy of Motor-Operated Valve Diagnostic Equipment," on June 28, 1993.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation project manager.

/s/'d by BKGrimes

Brian K. Grimes, Director

Division of Operating Reactor Support

Office of Nuclear Reactor Regulation

Technical Contacts:

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Attachments:

1. ITI MOVATS Report dated January 1993
2. List of Recently Issued NRC Information Notices

December 20, 1993

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 93-98: MOTOR BRAKES ON VALVE ACTUATOR MOTORS

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential problems with the performance of motor-operated valves (MOVs) resulting from improper operation of motor brakes used on valve actuator motors. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

Some MOVs have motor brakes installed to help minimize the inertial loads during valve closure after the control switch has tripped. Motor brakes also help prevent MOVs with non-locking gear mechanisms from inadvertently opening. One type of motor brake is designed to be electromagnetically released and has friction pads to slow the motor shaft following control switch trip. Improper operation of motor brakes can result in problems with the performance of MOVs.

Description of Circumstances

In Maintenance Update 92-2, Limitorque Corporation informed the nuclear industry that it had discovered, through operating experience and testing, that motor brakes do not substantially minimize the thrust load caused by inertia when closing MOVs. Limitorque also stated that it did not qualify motor brakes through its nuclear qualification testing. Limitorque warned that voltage variation into the motor brake may render the brake inoperable. Limitorque noted that disconnection of the brake leads does not render the brakes inoperable and specified that the friction pads be removed. Each of the following reports involve valves with Limitorque motor operators. On August 4, 1993, the licensee of Crystal River Nuclear Plant, Unit 3, reported (Licensee Event Report 93-008) that seven MOVs with motor brakes installed might receive insufficient voltage to allow the motor brakes to be released under degraded voltage conditions. Of these seven MOVs, the licensee declared a normally closed high-pressure injection suction MOV to be inoperable on July 6, 1993. The licensee removed the friction disks and electrical power connections from this MOV as well as from normally open borated water storage tank suction MOV. The licensee tested another of the seven MOVs to ensure that its motor brake would release under degraded voltage conditions. The remaining four MOVs are locked in their safety function position during plant operation.

On September 14, 1993, the licensee of Millstone Nuclear Power Station, Unit 2, notified NRC that it had declared four feedwater supply MOVs with motor brakes installed inoperable when it determined that the MOVs might receive insufficient voltage during degraded voltage conditions to allow the motor brakes to

release. The licensee relies on these MOVs as a backup for feedwater isolation in the event of a main steam line break. The licensee shut down Millstone Unit 2 in accordance with its plant technical specification requirements. The licensee subsequently removed the motor brakes.

On September 28, 1993, the licensee of James A. FitzPatrick Nuclear Power Plant notified NRC of problems with the operation of motor brakes on two low- pressure coolant injection MOVs. The licensee determined that the motor brakes were undersized to prevent the actuator spring pack from relaxing and causing the torque switch to restart the actuator motor on a repeated basis. Continuous restarting of the actuator motor can cause (1) damage to the motor from overheating, and (2) excessive stress to the MOV by driving the valve disk into its seat (sometimes referred to as a “hammering” effect).

Discussion

In Generic Letter (GL) 89-10, “Safety-Related Motor-Operated Valve Testing and Surveillance,” the NRC staff requested nuclear power plant licensees to confirm the capability of safety-related MOVs to perform their intended functions by reviewing MOV design bases, verifying MOV switch settings initially and periodically, testing MOVs under design-basis conditions where practicable, improving evaluations of MOV failures and necessary corrective action, and trending MOV problems. In response to GL 89-10, licensees are implementing programs to evaluate the design-basis capability of MOVs within the scope of the generic letter.

As indicated by the discovery of MOV operability problems at Crystal River and Millstone, some licensees may not be evaluating the minimum voltage required to ensure the proper operation of motor brakes when determining the design- basis capability of MOVs with motor brakes installed. Improper operation of motor brakes on MOVs could allow the motor to restart repeatedly as found at FitzPatrick.

Related Generic Communications

NRC has issued other information notices pertaining to MOVs. During the past year, these have included NRC Information Notices 93-74, “High Temperatures Reduce Limitorque AC Motor Operator Torque;” 93-54, “Motor-Operated Valve Actuator Thrust Variations Measured With a Torque Thrust Cell and a Strain Gage;” 93-01, “Accuracy of Motor-Operated Valve Diagnostic Equipment Manufactured by Liberty Technologies;” 92-83, “Thrust Limits for Limitorque Actuators and Potential Overstressing of Motor-Operated Valves;” and 92-70, “Westinghouse Motor-Operated Valve Performance Data Supplied to Nuclear Power Plant Licensees.”

In addition, the hammering effect was specifically addressed in NRC Information Notice 85-20, “Motor-Operated Valve Failures Due to Hammering Effect,” and its supplement.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation project manager.

ORIG /S/'D BY BKGRIMES

Brian K. Grimes, Director

Division of Operating Reactor Support

Office of Nuclear Reactor Regulation

March 16, 1994

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 94-18: ACCURACY OF MOTOR-OPERATED VALVE DIAGNOSTIC EQUIPMENT (RESPONSES TO SUPPLEMENT 5 TO GENERIC LETTER 89-10)

Purpose

This information notice is intended to alert addressees to information submitted by various nuclear power plant licensees related to the accuracy of motor-operated valve (MOV) diagnostic equipment. The information was submitted in response to Supplement 5, "Inaccuracy of Motor-Operated Valve Diagnostic Equipment," to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, related to operability of MOVs. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Background

In GL 89-10 (June 28, 1989), the NRC staff asked holders of operating licenses and construction permits for nuclear power plants to provide additional assurance of the capability of safety-related MOVs and certain other MOVs in safety-related systems to perform their intended functions by reviewing MOV design bases, verifying MOV switch settings initially and periodically, testing MOVs under design-basis conditions where practicable, improving evaluations of MOV failures and necessary corrective action and trending MOV problems. The NRC staff issued several supplements to GL 89-10 to clarify or modify its recommendations.

As an integral part of most GL 89-10 programs, licensees are relying on MOV diagnostic equipment to provide information on the thrust required to open or close the valve, as well as the thrust delivered by the motor actuator. The various types of MOV diagnostic equipment estimate stem thrust using different methods, such as spring pack displacement or strain in the stem, the mounting bolts, or the yoke. Because some licensees make decisions regarding the operability of safety-related MOVs on the bases of diagnostic equipment thrust readings, the accuracy of MOV diagnostic equipment can have a significant effect on the safe operation of a nuclear power plant. During the implementation of GL 89-10, the NRC staff became aware of new information on the accuracy of MOV diagnostic equipment. This new information raised a generic concern regarding the reliability of the data produced by MOV diagnostic equipment. For example, on February 3, 1992, the MOV Users Group (MUG) of nuclear power plant licensees released "Final Report - MUG Validation Testing as Performed at Idaho National Engineering Laboratories" (Volume 1). The report stated that the MOV diagnostic equipment that relied on spring pack displacement to estimate stem thrust was not as accurate as its vendors claimed. In addition, the NRC staff learned that specific MOV diagnostic equipment that relies on valve yoke strain to estimate stem thrust was less accurate than had been previously reported.

On March 2, 1992, the NRC staff held a public meeting with representatives of ITI-MOVATS to discuss the accuracy of the ITI-MOVATS thrust measuring device (TMD) to estimate stem thrust on the basis of spring pack displacement. At this meeting, the representatives of ITI-MOVATS described the results of their field validation program which showed that, in some instances, the TMD may be less accurate than licensees had assumed. The ITI-MOVATS representatives also discussed the results of their activities to resolve concerns about the fact that the TMD is calibrated in the valve opening direction, although it also is used to predict the thrust delivered by the actuator in the valve closing direction. ITI-MOVATS prepared Engineering Report 5.2 (March 13, 1992) to provide guidance to its licensee customers for evaluating the capability of an MOV to perform its safety function under design-basis conditions in light of the decreased accuracy of the TMD. The Nuclear Management and Resources Council (NUMARC) developed guidelines for licensees to use in evaluating MOVs that had been set up using the TMD.

ASEA-Brown Boveri (ABB) Impell manufactures MOV diagnostic equipment (known as OATIS) that relies on spring pack displacement to estimate stem thrust. Following the release of the MUG report, Impell representatives stated that they would be working with their licensee customers to develop new accuracy values.

Liberty Technologies has manufactured MOV diagnostic equipment, referred to as valve operation test and evaluation system (VOTES), that estimates the thrust required to open or close a valve based on the strain of the valve yoke. The VOTES system does this by measuring the diametral strain (the change in diameter) of the valve stem for a given yoke strain. The stem thrust is then calculated using the diametral strain and the nominal engineering properties of the stem. This stem thrust is compared to the yoke strain to provide a correlation between the yoke strain and the stem thrust. Once this correlation has been established, the stem thrust can be more easily determined by measuring the yoke strain. On October 2, 1992, Liberty Technologies notified the NRC, in accordance with 10 CFR Part 21, that it had found two new factors that can affect the thrust values obtained with its VOTES equipment. Those factors are (1) the possible use of improper stem material constants and (2) the failure to account for a torque effect when the equipment is calibrated by measuring the strain of the threaded portion of a valve stem.

In its October 2 submittal, Liberty Technologies provided guidance to licensees for correcting the thrust data by performing hand calculations, and stated that the new Version 2.3 of its VOTES software would be of help in performing the corrections.

On June 28, 1993, the NRC staff issued Supplement 5 to GL 89-10 requesting licensees and construction permit holders (1) to re-examine their MOV programs and to identify measures taken to account for uncertainties in properly setting valve operating thrust to ensure operability and (2) to evaluate the schedule necessary to first consider the new information on MOV diagnostic equipment inaccuracy and then to take appropriate action in response to that information. Within 90 days of receipt of Supplement 5 to GL 89-10, licensees were required (1) to notify the NRC staff of the diagnostic equipment used to confirm the proper size, or to establish settings, for safety-related MOVs, and (2) to report whether they had taken actions or planned to take actions (including schedule) to address the new information on the accuracy of MOV diagnostic equipment.

Description of Circumstances

The NRC staff has reviewed the responses to Supplement 5 to GL 89-10 submitted by licensees and construction permit holders. The staff has found that, for the most part, licensees and permit holders have been actively addressing the uncertainties regarding the accuracy of MOV diagnostic equipment. The newly recognized reduced accuracy of MOV diagnostic equipment can raise questions regarding (1) the adequacy of torque switch settings to provide sufficient thrust while not exceeding thrust or torque structural limits and (2) the capability of actuator motors with the present settings. In their responses, licensees and permit holders indicated that many MOVs had the potential for underthrusting or overthrusting as a result of the less-than-expected accuracy of MOV diagnostic equipment. Consequently, some licensees reported that MOVs have been retested, adjusted, or modified to resolve the concerns regarding the accuracy of MOV diagnostic equipment. The staff will discuss specific aspects of the response to Supplement 5 to GL 89-10 with individual licensees during future inspections.

The following is a summary of the issues relating to the accuracy of MOV diagnostic equipment as reported by licensees in their responses to Supplement 5 to GL 89-10.

12. 1. ITI-MOVATS Engineering Report 5.2 discussed the calibration of the ITI-MOVATS TMD in the open direction with reliance on the calibration to measure thrust in the close direction. This ITI-MOVATS report focuses on accuracy corrections for the TMD under static test conditions. The NRC staff knows of no ITI-MOVATS guidance related to accuracy corrections for the use of the TMD under dynamic test conditions.
13. 2. The temporary installation of the ITI-MOVATS torque thrust cell (TTC) for diagnostic testing can affect the actuator output thrust. ITI-MOVATS Special Test Report 6.0 addresses the actuator repositioning effect. The licensee of the Oyster Creek Nuclear Power Plant stated in its response to Supplement 5 to GL 89-10 that this special test report indicates that ITI-MOVATS recommends that actuator repeatability values and thrust/torque measurement error values be revised when using a temporarily installed TTC.
14. 3. The torque effects and the material characteristics that are relevant to the use of the Liberty Technologies' VOTES diagnostic equipment is discussed in this company's Part 21 notification of October 2, 1992.
15. 4. In addition to the issues involving torque effects and material characteristics, Liberty stated in its Part 21 notification of October 2, 1992, that (a) incorrect thrust readings can arise with the use of long cable lengths between the signal conditioning box and the breakout box when calibrating a VOTES sensor with a U-clamp or D-clamp; (b) under certain conditions, one or more of the four operational amplifiers in the breakout box oscillates and causes a thrust indication which can be lower or higher than actual by a factor of about two or four; and (c) CB 23-100 cables were mistakenly shipped without the offset resistor (which results in a lower-than-actual torque indication from the VTC load cell).

16. 5. The licensee of the Cooper Nuclear Power Plant reported in its response to Supplement 5 to GL 89-10 that Liberty Technologies is evaluating the issue of calibration of its equipment in one direction and reliance on thrust measurements in the other direction.
17. 6. The Cooper licensee reported that Liberty Customer Service Bulletin CSB-030 (May 6, 1993), "Proximity Probe Type Calibrators With a Possible 3% Shift in Sensitivity," alerts VOTES users to possible changes in the sensitivity of the proximity probe-type calibrator that can overpredict thrust readings.
18. 7. The licensee of the Susquehanna Nuclear Power Station reported in its response to Supplement 5 to GL 89-10 that factors that can affect VOTES accuracy are (a) the change in stem transition areas resulting from Liberty Technologies' refinement of its finite element model, (b) changes in effective stem diameters, (c) the need to differentiate between General Purpose ACME and Stub ACME threads when determining torque correction factors and effective stem diameters, and (d) new accuracy values based on torque correction values and percent extrapolation beyond calibration ranges.
19. 8. The licensee of the Maine Yankee Nuclear Power Plant noted in its response to Supplement 5 to GL 89-10 that it had submitted a notice in accordance with 10 CFR Part 21 on July 21, 1993, regarding its determination that the accuracy cited by Liberty Technologies for its VOTES equipment is only appropriate for torque switch trip when the Best-Fit-Straight-Line (BFSL) calibration method is used. As a result of this question regarding the accuracy of the VOTES calibration method, the Susquehanna licensee reported that its diagnostic tests will need to be repeated using the BFSL calibration method. Liberty Technologies is in the process of issuing a customer service bulletin that will give guidance on the inaccuracies of the results obtained by using the BFSL method. The service bulletin will also include a summary of a statistical analysis that was done to verify the accuracy of the BFSL method.

Related Generic Communications

The NRC has issued other generic communications on the accuracy of MOV diagnostic equipment. For example, the NRC issued Information Notice (IN) 92-23, "Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment," to alert licensees to the potential decreased accuracy of MOV diagnostic equipment manufactured by ITI-MOVATS and ABB Impell; and IN 93-01, "Accuracy of Motor-Operated Valve Diagnostic Equipment Manufactured by Liberty Technologies."

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below.

/s/ d by BKGrimes

Brian K. Grimes, Director

Division of Operating Reactor Support

Office of Nuclear Reactor Regulation

July 6, 1994

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 94-49: FAILURE OF TORQUE SWITCH ROLL PINS

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the potential inservice failure of the torque switch roll pin in Limitorque Corporation (Limitorque) actuators. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar failures. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

Pilgrim Nuclear Power Station, Unit 1:

On March 9, 1994, after a surveillance test of a motor-operated valve (MOV) in the high-pressure coolant injection (HPCI) system, the MOV could not be opened after being closed. The failed valve is a normally open test and maintenance valve on the pump discharge line. When closed, the valve maintains the pressure isolation boundary during inservice stroke time testing of the normally closed HPCI system injection valve; it receives an open signal upon initiation of the HPCI automatic start logic. The MOV breaker tripped open on overload and prevented the MOV from being opened remotely as designed. The valve is operated by a Limitorque SMB-0 actuator (Licensee Event Report (LER) 50-293/94-002).

Evaluation of this failure revealed that the direct cause of the inability of the MOV to open was the failure of the MOV torque switch drive pinion gear roll pin. With the roll pin broken, the torque switch did not deenergize the motor upon completing the close stroke and the MOV electrical breaker tripped open. The licensee, Boston Edison Company, declared the HPCI system inoperable and determined that an increase in the impact load on the roll pin apparently resulted from high pullout thrust and increased forces due to hardened grease in the torque switch spring pack. The licensee learned about a hammering of the torque switch on valve unseating observed at another nuclear power plant (described below for Washington Nuclear Project, Unit 2) and considered that this dynamic effect might also have contributed to the roll pin failure at the Pilgrim plant. The licensee concluded that the roll pin design, a small diameter pin (2.4 mm [3/32 in.]) made of relatively brittle high carbon steel (American Iron and Steel Institute (AISI) 1070), was the root cause of the failure.

The licensee opened the failed MOV to its safety position, returned the HPCI system to an operable status, and established corrective action to replace the failed torque switch model with one that has a larger diameter roll pin of improved material. The licensee evaluated the potential for this problem to affect those MOVs that must close during an accident scenario and subsequently reopen. The licensee determined that such MOVs are operable with the existing roll pin design. As MOVs are disassembled for

diagnostic testing, the licensee plans to install spring packs with internal relief devices to prevent grease hardening in the spring pack.

Hope Creek Nuclear Station, Unit 1:

On August 14, 1993, during inservice testing of valves, a HPCI pump discharge valve failed to fully open during an open stroke test. The valve, a 14-inch, horizontally mounted, flexible wedge gate valve, provides coolant from the HPCI system to the core spray system during actuation of the emergency core cooling system. The motor overload contacts for this same valve tripped during the subsequent close stroke. The valve is operated by a Limitorque SB-3 actuator (LER 50-354/93-005).

Evaluation of this failure revealed that the torque switch roll pin was broken, probably because of shearing forces. The failure of the roll pin allowed premature torque switch actuation on the open stroke and failure of torque switch actuation on the close stroke. The licensee, Public Service Electric and Gas Company, replaced the torque switch and is administratively controlling the number of valve strokes for this valve as part of an ongoing root-cause evaluation. The licensee plans to complete the root-cause evaluation and perform further diagnostic testing during the next planned outage in the spring of 1994.

Four previous torque switch roll pin failures have occurred at the Hope Creek Station. Three of these failures (March 1988, November 1989, and September 1991) involved the same HPCI pump discharge valve actuator that was involved in the failure that occurred in August 1993. The fourth failure, in November 1990, involved an SMB-1 actuator installed vertically in the HPCI steam supply line. Each of the valves is stroke-tested quarterly in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Inservice Testing."

Washington Nuclear Project, Unit 2:

In August 1993, the licensee, Washington Public Power Supply System, notified Limitorque about a problem with torque switch roll pins in MOV actuators with model numbers SB/SMB 0 through 5. The valves were apparently sticking in their seats when closed and causing increased stress on the torque switch roll pin during valve unseating (see Pilgrim LER 50-293/94-002).

Palo Verde Nuclear Station, Units 1, 2, 3:

On May 26, 1992, the licensee, Arizona Public Service Company, requested technical assistance in a letter to Limitorque to address failures of torque switch roll pins. The licensee had experienced at least 14 failures of pins (roll and groove pins) in torque switches on 10 different MOV actuators. Two failures occurred in actuators with model number SMB-00, two for SB-0, eight for SMB-1, and two for SB-3. (NRC Inspection Reports 50-528/94-11, 50-529/94-11, 50-530/94-11).

Using strain gages, the licensee found the dynamic torque during operation to be excessive during rapid acceleration (snapback) of the spring pack immediately following unseating of the valve. The licensee found that for actuators with model SB that have a lost motion drive sleeve (hammerblow feature), the compensator spring increased the snapback acceleration.

The licensee observed another effect of impact loading of the torque switch. During unseating of the valve, the torque switch contact bar flipped onto its side, interrupting electrical continuity and motor

operation as though the torque switch had actuated. The licensee replaced the contact bar compression springs with stiffer springs and attributed the root cause to the recoil force that impacts the contact bar when the valve is unseating.

Discussion

On March 23, 1994, Limitorque submitted a report to the NRC in response to the recent failures of torque switch roll pins, in accordance with Part 21 of Title 10 of the Code of Federal Regulations (Part 21 report). This report discusses potential failures of the torque switch roll pin in Limitorque MOV actuators with model numbers SMB/SB/SBD-0 through -4, -4T, -5, -5T, and -5XT. Limitorque stated that (1) it did not have the required expertise relative to valve and system design to perform a root cause analysis of these potential failures, (2) an affected isolation valve that must move from its open position to its closed position may not reopen reliably, (3) an affected injection valve would open and close, provided that no abnormal conditions were present during the previous valve closure, such as thermal overload trip or excessive motor current, (4) the licensee corrective action is to acquire and analyze site data relative to this issue, (5) Limitorque modified the roll pin design by replacing the 2.4 mm [3/32-in.] diameter pins with 3.2 mm [1/8-in.] diameter shear-proof pins and (6) Limitorque will replace the 303 stainless steel shaft material for new torque switches with 416 stainless steel material.

On December 11, 1990, Limitorque submitted a Part 21 report of the potential failure of the torque switch roll pin in SMB-00 actuators. This report limited the scope of concern to MOV actuators with model numbers SMB-, SB-, and SBD-00 that have heavy spring packs that are declutched under maximum rated load.

The recent torque switch roll pin failures occurred during motor-driven operation of the MOVs. In contrast, the Limitorque Part 21 report dated December 11, 1990, discusses failures during declutching of the actuator under loaded conditions to allow manual operation.

Related Generic Communications

Potential overthrusting of motor-operated valves is discussed in NRC Information Notice 92-83, "Thrust Limits for Limitorque Actuators and Potential Overstressing of Motor-Operated Valves," issued March 27, 1992.

Information Notice 92-83 discusses several industry qualification testing programs that are being used by licensees to increase motor-operated valve thrust allowable limits. These higher thrust limits may cause various actuator subcomponents, including torque switch roll pins, to be subjected to higher stress levels and thus to incur higher failure rates.

/s/'d by BKGrimes

Brian K. Grimes, Director

Division of Operating Reactor

Support Office of Nuclear Reactor Regulation

May 21, 1996

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 96-30: INACCURACY OF DIAGNOSTIC EQUIPMENT FOR MOTOR-OPERATED BUTTERFLY VALVES

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the increased inaccuracy of certain diagnostic equipment for measuring torque when operating butterfly valves. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," the NRC staff requested that nuclear power plant licensees and construction permit holders verify the design-basis capability of their safety-related motor-operated valves (MOVs). As an integral part of their MOV programs, most licensees rely on diagnostic equipment to provide information on the torque and thrust required to open and close valves, and the amount of torque and thrust delivered by the motor actuator. Various types of MOV diagnostic equipment are available to estimate torque and thrust for gate, globe, and butterfly valves. Because some licensees make decisions regarding the operability of safety-related MOVs on the basis of diagnostic equipment readings, inaccuracies in MOV diagnostic equipment can adversely affect the safe operation of a nuclear power plant.

On June 28, 1993, the NRC staff issued Supplement 5 to GL 89-10, "Inaccuracy of Motor-Operated Valve Diagnostic Equipment," which discussed then-recent information on the inaccuracy of MOV diagnostic equipment that raised a generic concern regarding the reliability of data provided by certain MOV diagnostic equipment. In Supplement 5 to GL 89-10, the staff stated that the MOV Users' Group of nuclear power plant licensees had released a report indicating that the MOV diagnostic equipment that relied on spring pack displacement to estimate stem thrust in gate and globe valves was less accurate than its vendors claimed. The staff also discussed greater-than- assumed inaccuracy of MOV diagnostic equipment that relies on valve yoke strain to estimate stem thrust in gate and globe valves. As a result of the inaccuracy concerns for MOV diagnostic equipment used with gate and globe valves, the staff (in Supplement 5 to GL 89-10) asked licensees to reexamine their MOV programs and to report measures taken or planned to account for uncertainties in properly setting valve operating thrust to ensure operability. The staff stated that licensees should not limit their evaluations to only the specific examples of increased inaccuracy of MOV diagnostic equipment discussed in Supplement 5, but should consider any information reasonably available to them. The staff reviewed the licensees' responses to Supplement 5 to GL 89-10 and conducted additional evaluations during GL 89-10 inspections.

Description of Circumstances

ITI MOVATS Incorporated developed the Butterfly Analysis and Review Test (BART) System as a method for determining the torque output of Limitorque HBC gear boxes equipped with Limitorque motor actuators on butterfly valves. In the BART System, a load cell is mounted between the HBC gearbox housing and the HBC worm gear. Actuator torque is determined by multiplying the force resisted in the load cell by the length of the moment arm. In MOVATS Users Technical Notice (MUTN) 96-01 (dated April 1996), ITI MOVATS stated that the inaccuracy of the BART System had been considered to be equal to the inaccuracy of the load cell (plus or minus the sum of 2 percent of reading and 0.4 percent of full scale). However, recent observations and questions concerning the performance of the BART System under field conditions led ITI MOVATS to perform testing to determine the inaccuracy of the system. In MUTN 96-01, ITI MOVATS reports that its test program revealed the inaccuracy of the various fixture sizes of the BART System to be as follows:

Fixture Size	Inaccuracy
H0BC, H1BC, H2BC	+(14.0% of reading + 5.2% of full scale) -(4.0% of reading + 1.0% of full scale)
H3BC	+(14.0% of reading + 746 foot-pounds) -(14.0% of reading + 311 foot-pounds)

ITI MOVATS notes that the effects of both torque switch repeatability and HBC gear box repeatability are included in the new inaccuracy values. The vendor also states that these inaccuracy values are only valid for torque loads between 20 percent and 100 percent of the full-load rating of the HBC gear box. ITI MOVATS offers no guidance in MUTN 96-01 for predicting inaccuracy outside of this load range.

Discussion

The BART System is typically used to determine torque output at torque switch trip when operating motor-operated butterfly valves under static (no flow) conditions. Overprediction of actual torque at the torque switch trip could result in the motor actuator failing to fully stroke the valve under dynamic flow conditions. Underprediction of actual torque at the torque switch trip could result in exceeding actuator or valve structural limits, or degraded-voltage motor capability. Depending on the use of the diagnostic system and the control circuitry of the motor actuator, the operation of limit-switch-controlled butterfly valves might also be adversely affected by the increased inaccuracy of the BART System.

In MUTN 96-01, ITI MOVATS recommends that all quarter-turn valves that have been set up using the BART System be reevaluated using the revised values for inaccuracy. The vendor also suggests that, when using the BART System of sizes H0BC, H1BC, and H2BC, the open and close strokes should begin with the load cell in the relaxed position to simplify determination of zero load. This information notice is

being issued because valves that were marginally operable assuming the old inaccuracy may be inoperable based on the new inaccuracy.

Related Generic Communications

The staff has alerted the industry to concerns about inaccuracy regarding other MOV diagnostic equipment. For example, the staff issued Information Notice (IN) 92-23, "Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment;" IN 93-01, "Accuracy of Motor-Operated Valve Diagnostic Equipment Manufactured by Liberty Technologies;" and IN 94-18, "Accuracy of Motor-Operated Valve Diagnostic Equipment (Responses to Supplement 5 to GL 89-10)."

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

signed by

Brian K. Grimes, Acting Director

Division of Reactor Program Management

Office of Nuclear Reactor Regulation

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August 21, 1996

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 96-48: MOTOR-OPERATED VALVE PERFORMANCE ISSUES

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to (1) lessons learned from the Electric Power Research Institute (EPRI) Motor-Operated Valve (MOV) Performance Prediction Program, (2) performance problems with MOV key failures described in a recent NRC Office for Analysis and Evaluation of Operational Data (AEOD) study, and (3) the potential for torque output from MOV actuators to be less than predicted by Limitorque Corporation. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In the 1980s, continuing problems with the performance of MOVs at nuclear power plants raised concerns regarding MOV design, testing, and maintenance. In response to these problems, both the nuclear industry and NRC initiated efforts to improve the performance of MOVs at nuclear plants. In 1989, the NRC staff issued Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," requesting that nuclear power plant licensees and construction permit holders verify the design-basis capability of their safety-related MOVs. In response to GL 89-10, the nuclear industry has studied the performance of MOVs through testing and analyses. As a result of these activities, some weaknesses in the design and manufacture of MOVs were discovered through evaluation of the performance history of MOVs. In this information notice, the staff discusses three issues involving MOV performance that have been identified.

Description of Circumstances

1. Lessons Learned from EPRI MOV Performance Prediction Program

As part of the industry effort regarding the MOV issue, EPRI initiated an MOV Performance Prediction Program to develop a methodology to be used by licensees in demonstrating the design-basis capability of MOVs when valve-specific design-basis test data are not available. The program included development of improved methods for prediction or evaluation of system flow parameters; gate, globe, and butterfly valve performance; and motor actuator rate-of-loading effects (load-sensitive behavior). Further, EPRI performed testing to provide information for refining the gate valve model and rate-of-loading methods and conducted numerous MOV tests to provide data for model and method development and validation, including flow loop testing, parametric flow loop testing of butterfly valve disk designs, and in situ MOV testing.

In November 1994, the Nuclear Energy Institute (NEI) submitted the proprietary EPRI Topical Report TR-103237, "EPRI MOV Performance Prediction Program—Topical Report," for review by the NRC staff. EPRI prepared 25 additional reports to support the topical report. On March 15, 1996, the NRC staff issued a Safety Evaluation (SE) documenting the staff review of the topical report. With the conditions and limitations described in the SE, the staff stated that the EPRI program provides an acceptable methodology to predict the thrust or torque required to operate gate, globe, and butterfly valves within the scope of the EPRI program and to bound the effects of load-sensitive behavior on motor actuator thrust output.

In a letter dated September 27, 1995, NEI forwarded a summary of important contributions and findings resulting from the EPRI MOV Performance Prediction Program. As described in an enclosure to the NEI letter, important findings (or confirmatory information) from the EPRI MOV program include the following:

- a. The traditional methods for predicting gate valve performance might be nonconservative for many applications because of incomplete equations, design features, manufacturing controls, and wide-ranging friction coefficients
- b. The edge radii on disk seats and guide slots are critical to gate valve performance and predictability
- c. Stellite friction coefficients increase with differential-pressure valve strokes in cold water to a plateau level, stabilize quickly in hot water, and decrease as differential pressure increases
- d. Gate valves with carbon steel guides and disk guide slots with tight clearances might fail to close under blowdown conditions
- e. Many existing gate valve manufacturing and design processes and controls, and plant maintenance practices, might contribute to poor valve performance
- f. Traditional methods for predicting globe valve performance for incompressible flow conditions are nonconservative for globe valves in which differential pressure acts across the plug guide
- g. Globe valve thrust requirements for some designs can be excessive under compressible flow and blowdown conditions because of the potential for plug-side loading
- h. Rate-of-loading effects (load-sensitive behavior) can reduce the static thrust output by up to 30 percent under dynamic conditions
- i. Hydrodynamic torque coefficients used by some butterfly valve manufacturers might be nonconservative for certain applications, with valves located near piping elbows especially vulnerable
- j. Butterfly valve seats should be periodically replaced to avoid hardening or degradation.

In addition to these reported important findings, EPRI confirmed that thrust requirements to unwedge a gate valve can be higher under dynamic conditions than under static conditions.

1. MOV Key Failures

On March 29, 1996, AEOD issued report AEOD/E96-01, entitled, "Engineering Evaluation - Motor-Operated Valve Key Failures," on the continuing occurrence of problems with keys in MOVs at nuclear power plants. A significant number of MOV key failures have been identified that involved (a) anti-rotation keys, (b) valve operator-to-valve stem keys, and (c) motor pinion gear keys. A total of 73 reports were written involving MOV key failures between January 1990 through September 1995. Many of these key failures were not detected during surveillance tests but were detected on demand, during valve operations, or during maintenance activities and had existed for some time before they were discovered. A number of key failures were discovered during maintenance activities even though the valves had been operated satisfactorily and passed all previous surveillance tests.

2. Limitorque Motor Actuator Performance

In 1977, Limitorque Corporation established guidelines (referred to as the SEL documents) for sizing ac-powered motor actuators used in MOVs. Those guidelines predicted the motor actuator output torque as a product of the nominal motor-rated start torque, pullout efficiency, application factor (typically 0.9), overall actuator gear ratio, and a degraded voltage factor. Over the past few years, Limitorque has accepted the use of run efficiency for closing valves powered by ac-powered motor actuators. Limitorque has also stated that licensees may eliminate the application factor when voltage supplied to the motor is less than 90 percent of its rated voltage. (See Limitorque Technical Update 93-03 [Accession 9608120083].) Recent industry and NRC-sponsored test information has raised questions regarding the accuracy of the Limitorque assumptions for actuator efficiency.

Discussion

3. Lessons Learned from the EPRI MOV Performance Prediction Program

As discussed in the staff SE on the EPRI topical report, the EPRI program provided important information on the design, testing, and maintenance of MOVs in nuclear power plants. Some of the EPRI information is applicable to gate, globe, and butterfly valves regardless of the type of actuator operating the valve. Examples of such information are given below:

Gate Valves:

Almost all flow testing by licensees in response to GL 89-10 was conducted under pumped-flow conditions. Several gate valves tested by EPRI under blowdown conditions demonstrated unpredictable performance and internal damage. Extrapolation of test data from pumped-flow conditions to blowdown conditions may not be sufficient to ensure that a gate valve can operate under its design-basis conditions.

Valve aging conditions can influence gate valve performance. The thrust requirements to operate gate valves under normal flow conditions can increase with time and valve stroking.

Thrust requirements to unwedge gate valves under dynamic conditions may be greater than under static conditions.

Globe Valves:

Limited testing by EPRI of globe valves under blowdown or high-temperature flow conditions suggested that higher thrust than typically predicted may be required to operate these valves.

Thrust requirements for globe valves are influenced by the area of the valve seat or guide, depending on the valve design.

The EPRI test database is not sufficient to justify modifying the Limitorque guidelines for sizing and setting globe valves to lower the typical valve factor of 1.1 assumed in the guidelines.

Butterfly Valves:

Several areas of the EPRI Butterfly Valve Application Guide need improvement or correction. EPRI is currently revising the application guide and plans to include new information on flow and torque coefficients; system analysis techniques; treatment of bearing, packing, and hub-seal torque; upstream elbow modeling; and rated and survivable torque calculations.

4. MOV Key Failures

The MOV key failures may involve a common-cause failure that could render redundant trains of certain safety-related systems inoperable if they had remained undetected. The MOV key failures can be attributed to (a) installation and design deficiencies for anti-rotation keys, (b) loosening or slipping, wear or normal aging, excessive force or overtorque, and discrepancies in material or size for valve operator-to-valve stem keys, and (c) high-impact loads, improper materials, installation deficiency, wear or normal aging, and vibration for motor pinion gear keys.

The anti-rotation key failures involving installation deficiencies were generally associated with inadequate staking and securing of setscrews during installation of the keys. It appeared that the installation instructions provided by the vendors were not always included in licensee maintenance procedures.

Many motor pinion gear key failures involving an installation deficiency were due to failure to stake the keys following replacement of the motors or the pinion gears. Although licensees revised their MOV maintenance procedures to include restaking the pinion key or motor shaft as recommended by Limitorque Maintenance Update 89-1 (Accession 9608120068), many licensees did not investigate the potential problems of maintenance activities that were conducted before their procedure changes.

The motor pinion gear key failures attributable to high-impact loads or improper material appear to involve AISI (American Iron and Steel Institute) type 1018 keys in high-speed and high-inertia configurations. The replacement of 1018 keys with harder 4140 keys in some cases may lead to keyway deformation or damage, depending on impact loads and the shaft material. The situation may present a complex stress problem that is not completely considered in design and could produce a severe and complex stress concentration on the key, as well as the keyway. This situation could lead to cracking and failure of the shaft.

The potential for these key problems to render safety systems inoperable emphasizes (a) the importance of plant maintenance programs in assuring that MOV keys are staked and secured as required, (b) the importance of plant MOV surveillance and maintenance activities in the early detection of key degradation, and (c) the possibility of shaft cracking as a result of replacement of 1018 keys with harder material when the replacement will involve a relatively soft shaft and high impact loads.

5. Limitorque Motor Actuator Performance

The NRC staff conducted an inspection at Limitorque in May 1993 and reviewed the basis for its motor actuator sizing guidelines. As discussed in NRC Inspection Report 99900100/93-01, the staff found that the values for individual parameters assumed in the Limitorque sizing equation were not determined by testing but were founded primarily on engineering judgment. The lack of significant failure history of motor actuators when using the Limitorque sizing equation has been the primary basis for confidence in the equation. Licensee modifications of the parameters in the Limitorque sizing guidelines has the potential to influence performance.

Tests of MOVs under differential pressure and flow conditions performed by licensees in response to GL 89-10 have revealed that significantly more torque and thrust are required to open and close many gate valves than predicted by the valve vendors. This need for more torque than originally believed has led licensees to evaluate the Limitorque motor actuator sizing guidelines to determine whether more torque output is available from the motor actuators than was predicted by the guidelines. The Limitorque sizing guidelines have typically been assumed to underestimate the output torque capability of motor actuators. Therefore, some licensees eliminate the application factor from the output torque equation and use run efficiency for ac-powered MOVs in the closing direction. Further, some licensees have asserted that motor torque greater than the nominal start rating may be assumed in the sizing guidelines because motors typically deliver more torque than their rating before they stall.

In response to the questions surrounding the Limitorque sizing equation, the NRC Office of Nuclear Regulatory Research evaluated the performance of Limitorque motor actuators through testing at the Idaho National Engineering Laboratory (INEL). Preliminary results of the INEL tests suggest that (1) motor output is greater than the nominal rating for many motors, (2) the actual output efficiency may not reach "run" efficiency for some Limitorque actuators and may drop below "pullout" efficiency under high loads, (3) the torque loss under degraded voltage conditions can be more severe for some ac motors than the typically assumed square of the ratio of actual voltage to rated voltage, and (4) the torque loss under degraded voltage conditions can be more severe for some dc motors than the typically assumed linear ratio. Preliminary results of this testing are documented in NUREG/CR-6100, "Gate Valve and Motor-Operator Research Findings" (September 1995). INEL is preparing a report, NUREG/CR-6478, to document its recent findings in this area. This report is scheduled to be issued by the end of 1996.

At meetings of the Motor-Operated Valve Users' Group of nuclear power plant licensees in February and July 1995, Commonwealth Edison (ComEd) presented the results of its motor and actuator output testing program. The testing conducted by ComEd was more extensive than the NRC-sponsored testing and revealed similar results. Previously, in NUREG/CP-0137, "Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing" (July 1994), motor actuator testing by Texas Utilities raised questions regarding Limitorque motor actuator output. Texas Utilities also found lower output during in situ motor actuator testing compared to torque stand testing.

This information raises concerns regarding the basis for Limitorque acceptance of licensee assumptions that the torque output of its actuators is greater than predicted by the original Limitorque SEL guidelines. The NRC staff has been discussing with Limitorque the discrepancy between guidance relaxing the original motor actuator sizing criteria and the recent motor actuator test results. The manufacturer has stated that updated information for the industry on the sizing of its motor actuators is being developed.

Related Generic Communications

6. NRC IN 81-08, "Repetitive Failures of Limitorque Operator SMB-4 Motor-to-Shaft Key," March 20, 1981 (Accession 8011040272).
7. NRC IN 88-84, "Defective Motor Shaft Keys in Limitorque Motor Actuators," October 20, 1988 (Accession 8810140018).
8. NRC GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," June 28, 1989 (Accession 8906290082).
9. NRC IN 90-37, "Sheared Pinion Gear-to-Shaft Keys in Limitorque Motor Actuators," May 24, 1990 (Accession 9005180095).
10. NRC IN 90-40, "Results of NRC-Sponsored Testing of Motor-Operated Valves," June 5, 1990 (Accession 9005290270).
11. NRC IN 93-42, "Failure of Anti-Rotation Keys in Motor-Operated Valves Manufactured by Velan," June 9, 1993 (Accession 9306030147).
12. NRC IN 93-88, "Status of Motor-Operated Valve Performance Prediction Program by the Electric Power Research Institute," November 30, 1993 (Accession 93111904527).
13. NRC IN 94-10, "Failures of Motor-Operated Valve Electric Power Train Due to Sheared or Dislodged Motor Pinion Gear Key," February 4, 1994 (Accession 9402010052).
14. NRC IN 94-69, "Potential Inadequacies in the Prediction of Torque Requirements for and Torque Output of Motor-Operated Butterfly Valves," September 28, 1994 (Accession 9409210211).

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

signed by B.K. Grimes

Thomas T. Martin, Director

Division of Reactor Program Management

Office of Nuclear Reactor Regulation

July 24, 1998

To: All Holders of Operating Licenses for Nuclear Power Reactors Except Those Who have Permanently Ceased Operation and Have Certified that Fuel has been Permanently Removed from the Reactor Vessel

Subject: INFORMATION NOTICE 96-48, SUPPLEMENT 1 MOTOR-OPERATED VALVE PERFORMANCE ISSUES

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to recent guidance from Limitorque Corporation for predicting torque output from its motor actuators used to open and close motor-operated valves (MOVs). This supplement to NRC Information Notice (IN) 96-48 (August 21, 1996), "Motor-Operated Valve Performance Issues," revises the information on motor actuator output presented earlier. The information in IN 96-48 on the Electric Power Research Institute (EPRI) MOV Performance Prediction Program and on the failure of MOV keys is not affected by this supplement's updated information on motor actuator output. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

As discussed in IN 96-48, Limitorque Corporation established a standard practice for determining the appropriate size of motor actuators as described in its "SEL" documents in the 1970s. According to those documents, Limitorque predicts the torque output of MOV actuators through the use of the following equation:

$$\text{Actuator torque} = (\text{MT})(\text{Eff})(\text{AF})(\text{OAR})(\text{DVF})$$

where MT = motor torque

Eff = actuator gear efficiency

AF = application factor

OAR = overall actuator gear ratio

DVF = degraded voltage factor

Limitorque provided additional information on the sizing of motor actuators in its Technical Update 92-02 (dated October 9, 1992).

In the SEL documents and Technical Update 92-02, Limitorque specified the following to be assumed in the equation for sizing ac-powered motor actuators:

MT = nominal motor starting torque,

Eff = “pullout” gear efficiency from a table provided by Limitorque for the specific actuator size and gear ratio,

AF = 0.9 or lower, depending on the particular application,

OAR = overall actuator gear ratio based on the particular actuator,
and

DVF = square of the ratio of actual to rated motor voltage

The NRC staff reviewed the criteria for sizing motor actuators established by Limitorque during an inspection in 1993. The NRC staff found Limitorque's assumptions for the individual parameters in the sizing criteria to be based primarily on engineering judgment without independent justification. However, the NRC staff retained confidence in the prediction of output torque based on the success of the Limitorque criteria in sizing motor actuators over the previous years. For more information on the inspection findings, see NRC Inspection Report 99900100/93-01, dated June 28, 1993 (Accession Nos. 9308180192, 9308180201, and 9308180277).

In the early 1990s, dynamic tests of MOVs by nuclear power plant licensees in response to Generic Letter (GL) 89-10, “Safety-Related Motor-Operated Valve Testing and Surveillance,” revealed that valve vendors had significantly underpredicted the operating requirements for many safety-related valves under their design-basis conditions. This finding led licensees to request that Limitorque relax certain criteria used in the sizing equation for ac-powered motor actuators which would result in predicting higher actuator output torque. For example, Limitorque allowed particular licensees to assume 110 percent of the rated motor starting torque and a “run” efficiency (up to 20 to 30 percent greater than the “pullout” efficiency) for specific MOVs and their application. Further, Limitorque Technical Update 93-03 (dated September 1993) allowed licensees to assume an application factor of 1.0 (rather than 0.9) where the motor voltage was less than 90 percent of the motor's rated voltage. As a result of such relaxations of

Limitorque's motor actuator sizing criteria, many licensees revised their MOV calculations to incorporate the relaxed criteria for all ac-powered motor actuators.

Description of Circumstances

In 1994, concerns were raised about the adequacy of Limitorque's relaxed criteria in reliably predicting the torque output of ac-powered motor actuators. In a paper presented by Texas Utilities Electric Company at an NRC/ASME Symposium on Valve and Pump Testing in July 1994, it generally appeared that the actuator sizing method would only be adequate if the original sizing criteria were used with "pullout" efficiency and a 0.9 application factor assumed. (See NUREG/CP-0137 (July 1994), "Proceedings of the Third NRC/ASME Symposium on Valve and Pump Testing.") At another NRC/ASME symposium in July 1996, Commonwealth Edison Company reported that its review of available test data indicated that use of "pullout" efficiency combined with a 0.9 application factor was needed to establish a conservative lower bound for actual actuator gear efficiencies. (See NUREG/CP-0152 (July 1996), "Proceedings of the Fourth NRC/ASME Symposium on Valve and Pump Testing.") Also at the July 1996 symposium, the Idaho National Engineering and Environmental Laboratory (INEEL) reported that preliminary results of tests sponsored by the NRC Office of Nuclear Regulatory Research similarly suggested the need to combine "pullout" efficiency with a 0.9 application factor to reliably predict the actuator gear efficiency. In IN 96-48, the NRC staff alerted licensees to these results of NRC-sponsored and industry tests of motor actuator output.

In July 1997, the NRC issued NUREG/CR-6478, "Motor Operated Valve (MOV) Actuator Motor and Gearbox Testing," which described in detail the results of the NRC-sponsored tests of motor actuator performance. The testing program revealed that motor output was typically greater than nominal starting torque. However, the program indicated that actuator efficiency was normally less than "run" efficiency (and in some cases even less than "pullout" efficiency), and that motor output under degraded voltage conditions was less than predicted by the square of the ratio of actual to rated motor voltage.

In IN 96-48, the NRC staff stated that it was discussing with Limitorque the discrepancy between guidance relaxing the original motor actuator sizing criteria and the recent motor actuator test results. The NRC staff also stated that Limitorque was developing updated information for the industry on the sizing of its motor actuators. At an MOV Users Group meeting of nuclear power plant licensees in December 1997, Limitorque informed the licensees that it was considering retracting its previous relaxation of the sizing criteria and that it would issue a documented notification. In April 1998, the NRC staff conducted an inspection at Limitorque of the manufacturer's response to the information on the adequacy of its relaxation of the ac-powered motor actuator sizing criteria. For information on the specific inspection findings, see NRC Inspection Report 99900100/98-01, dated July 13, 1998.

Discussion

On May 15, 1998, Limitorque prepared Technical Update 98-01 to provide updated guidance for determining the output torque capability of an ac-powered Limitorque motor actuator. In that update, Limitorque specifies that, in the sizing equation, licensees should use nominal motor starting torque, "pullout" efficiency, overall actuator gear ratio based on the particular actuator and an application factor (typically 0.9), and should apply an exponent of 2 to the ratio of actual to rated motor voltage. Where voltage exceeds 90 percent of the motor's rated voltage, Limitorque allows customers to disregard the degraded voltage factor because of standard motor design characteristics. Limitorque also allows customers to use more optimistic assumptions than are specified in Technical Update 98-01 whenever actual test data or certain engineering data are available. In light of available test data, Limitorque alerts customers to specific motor actuators that require special attention in determining output torque capability. Limitorque guidelines for considering the effects of elevated temperature on ac-powered motor starting torque continue to be provided in Limitorque Technical Update 93-03.

With respect to dc-powered motor actuators, the sizing equation developed by Limitorque in the SEL documents is similar to the one used for ac-powered motor actuators. The assumptions in the sizing equation for dc-powered motor actuators include nominal motor starting torque, application factor, "pullout" efficiency, overall actuator gear ratio based on the particular actuator and a degraded voltage factor where an exponent of 1 is applied to the ratio of actual to rated motor voltage. The NRC Office of Nuclear Regulatory Research is presently sponsoring a program at the INEEL to study the performance of dc-powered motor actuators and to provide a basis for re-evaluating initial test results for a dc-powered motor actuator described in NUREG/CR-6478. Limitorque will review the information on the output of dc-powered motor actuators to determine whether the sizing guidance needs to be updated.

In summary, in light of recent tests and studies of motor-actuator output, Limitorque has retracted its relaxation of the sizing criteria for ac-powered motor actuators through issuance of Limitorque Technical Update 98-01. Limitorque has conducted workshops with nuclear power plant licensees to discuss its updated guidance on sizing ac-powered motor actuators. Limitorque is continuing to evaluate its sizing guidance for dc-powered motor actuators. The NRC staff will be evaluating licensee consideration of the updated Limitorque guidance as part of its review of MOV programs developed in response to GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves."

Related Generic Communications

NRC Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," June 28, 1989.

NRC Generic Letter 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," September 18, 1996.

NRC Information Notice 96-48, "Motor-Operated Valve Performance Issues," August 21, 1996.

NRC Information Notice 97-07, "Problems Identified During Generic Letter 89-10 Closeout Inspections," March 6, 1997.

This information notice requires no specific action or written response. However, recipients are reminded that they are required by 10 CFR 50.65 to take industry-wide operating experience (including information presented in NRC Information Notices) into consideration, where practical, when setting goals and performing periodic evaluations. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

/s/'d by

Jack W. Roe, Acting Director

Division of Reactor Program Management

Office of Nuclear Reactor Regulation

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March 6, 1997

To: All Holders of Operating Licenses or Construction Permits for Nuclear Power Reactors

Subject: NRC INFORMATION NOTICE 97-07: PROBLEMS IDENTIFIED DURING GENERIC LETTER 89-10 CLOSEOUT INSPECTIONS

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to the general conclusions derived from NRC inspections of programs developed at nuclear power plants in response to Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance." It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Background

In response to operating events, research results, and the findings in NRC Bulletin 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients due to Improper Switch Settings," the NRC staff requested in GL 89-10 that holders of nuclear power plant operating licenses and construction permits ensure the design-basis capability of their safety-related motor-operated valves (MOV) by periodically reviewing MOV design bases, verifying MOV switch settings, testing MOVs under design-basis conditions where practicable, improving evaluations and corrective actions associated with MOV failures, and determining trends of MOV problems. The NRC staff issued seven supplements to GL 89-10 to provide further guidance to the industry on implementation of the generic letter.

On September 18, 1996, the NRC staff issued GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves." GL 96-05 contains detailed guidance on the development of long-term programs to ensure the design-basis capability of safety-related MOVs. It also includes updated information on long-term MOV performance. In the area of MOV periodic verification, the recommendations of GL 96-05 supersede those of GL 89-10.

Over a number of years, industry and NRC activities associated with GL 89-10 have increased, reflecting both the evolution of technological development and experience gained over time and the rising expectations of both the industry and the NRC staff. Activities have included generic communications, workshops, MOV Users' Group meetings, symposia on pumps and valves, and a massive MOV testing and analysis effort by the Electric Power Research Institute (EPRI). As a result, information on MOV performance has been widely disseminated over the past few years.

Description of Circumstances

Most nuclear power plant licensees have notified the NRC that they consider their programs to verify the design-basis capability of safety-related MOVs in response to GL 89-10 to be complete. The NRC staff has been conducting inspections of the development, implementation, and completion of these programs. In performing the inspections, the NRC staff has followed Temporary Instruction (TI) 2515/109, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance." The NRC staff recently updated this TI to provide guidance on GL 89-10 closeout inspections and on the scope of GL 89-10 programs. The NRC staff plans to complete its review of the GL 89-10 programs at most nuclear plants in 1997.

Through MOV testing, analyses, and operational events over the past few years, the nuclear industry and the NRC staff have identified weaknesses in the original design, manufacture, maintenance, and testing of safety-related MOVs. During inspections to review completion of GL 89-10 programs, the NRC staff has found that some licensees have not fully verified the design-basis capability of their safety-related MOVs. For example, the NRC staff has found that little testing bases existed in support of original assumptions by some licensees (and actuator and valve manufacturers) for friction coefficients and efficiencies affecting thrust and torque requirements and actuator output when sizing and setting MOVs. As a result, licensees have had unexpected difficulty in demonstrating to the staff that they have adequately completed their GL 89-10 programs.

When reviewing the development and implementation phases of the GL 89-10 programs, the NRC inspectors identified specific items and concerns that needed attention before completion of the programs. These items and concerns are discussed in the inspection reports prepared by the NRC staff. During inspections to evaluate completion of the GL 89-10 programs, the NRC staff found that some licensees had not resolved the items and concerns identified in the previous inspection reports. In addition, some licensees had not recognized that the MOV program has to be kept up to date on the basis of new information on MOV performance.

In GL 89-10, the NRC staff recommended that MOVs within the scope of the generic letter be tested under design-basis conditions where practicable. In Supplement 6 to GL 89-10, the NRC staff provided guidance for licensees on grouping MOVs that were not practicable to test dynamically. Some licensees have also chosen to group MOVs to minimize the amount of dynamic testing under their GL 89-10 programs. The MOV grouping guidelines recommend that dynamic test data be obtained on a reasonable sample of MOVs and that the resulting information be applied to the remaining MOVs in the group.

During GL 89-10 closeout inspections, the NRC staff found that some licensees provided weak justification for the design-basis capability of MOVs that have not been dynamically tested. As stated in Supplement 6 to GL 89-10, the NRC staff considers plant-specific test data to be the best source of information when attempting to justify the design-basis capability of MOVs. The plant-specific test data would be obtained from the specific MOV being evaluated or, if testing was not practicable, from other similar MOVs under similar fluid conditions at the plant.

In developing the justification for the design-basis capability of MOVs that are not dynamically tested, it

is important to consider the extent and reliability of the information being applied to the MOV under evaluation. For example, MOVs of similar manufacture and fluid conditions have been found to have a range of performance characteristics. Therefore, reliance on data from a few MOVs tested under industry programs or at other plants might be insufficient to justify the design-basis capability of similar MOVs at a specific plant. Plant-specific testing needs to be repeatable or at least validated through the performance of statistically valid testing.

If MOV-specific data and plant-specific data for similar MOVs are not available, other sources of information appropriate for the plant's MOVs must be found. In the search for this information, the range of performance under similar fluid conditions needs to be considered. For example, EPRI made significant efforts to predict bounding thrust requirements through its program of separate effects tests, flow loop testing, and analytical methodology. In a safety evaluation (SE) dated March 15, 1996 (Accession number 9608070280), the NRC staff approved the EPRI MOV Performance Prediction Methodology (PPM) when used in accordance with certain conditions and limitations. Selective application of the EPRI test data or methodology might not be reliable without full consideration of the NRC staff SE on the EPRI PPM. Further, the NRC staff has determined that it is difficult to select the specific point of flow isolation of tested valves and to apply flow isolation data from one valve to another.

Key parameters to be addressed in verifying the design-basis capability of MOVs are valve friction coefficients (i.e., valve factor), stem friction coefficients, and load sensitive behavior (i.e., rate-of-loading effects). During GL 89-10 closeout inspections, the NRC staff found that some licensees were using qualitative arguments to justify assumptions for these quantitative parameters. As discussed previously, MOVs that have not been dynamically tested need to have adequate justification for their design-basis capability. The most reliable source of information on valve friction coefficients, stem friction coefficients, and load sensitive behavior is the specific licensee's plant. Licensees can best demonstrate the validity of their assumptions for these parameters by ensuring that sufficient test data are available for their specific plants and by analyzing the data for the plant- and valve-specific parameters.

Pressure locking and thermal binding of gate valves were particular MOV performance problems identified in GL 89-10. To some extent, the NRC staff has addressed licensee responses to this issue in GL 89-10 inspections. The NRC staff issued GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," to provide specific recommendations to licensees and to request their responses in regard to pressure locking and thermal binding of gate valves. GL 95-07 also requested that licensees submit their responses to this issue separate from their submittals on their GL 89-10 programs. Nevertheless, the NRC staff may request information from licensees during GL 89-10 inspections regarding the operability of specific MOVs found to be susceptible to pressure locking or thermal binding.

On February 28, 1992, the NRC staff issued NRC Information Notice (IN) 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire." In that IN, the NRC staff alerted licensees to conditions (sometimes referred to as "hot shorts") found at several plants that could result in the loss of capability to maintain the reactor in a safe shutdown condition in the unlikely event that a control room fire forced reactor operators to evacuate the control room. During NRC inspections of MOV programs

and other licensee activities, the NRC staff has identified weaknesses in the responses of some licensees to potential short-circuiting of MOV control circuitry in the event of a plant fire.

Attachment 1 to this information notice contains examples of licensee problems in supporting specific aspects of their bases for stating GL 89-10 actions have been completed. Attachment 2 contains a list of recently issued NRC information notices.

Related Generic Communications

BL 85-03, "Motor-Operated Valve Common Mode Failures During Plant Transients Due to Improper Switch Settings," dated November 15, 1985

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," dated June 28, 1989

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 1 dated June 13, 1990

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 2 dated August 3, 1990

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 3 dated October 25, 1990

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 4 dated February 12, 1992

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 5 dated June 28, 1993

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 6 dated March 8, 1994

GL 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," Sup. 7 dated January 24, 1996

GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power- Operated Gate Valves," dated August 17, 1995

GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," dated September 18, 1996

IN 92-17, "NRC Inspections of Programs Being Developed at Nuclear Power Plants in Response to Generic Letter 89-10," dated February 26, 1992

IN 92-18, "Potential for Loss of Remote Shutdown Capability during a Control Room Fire," dated February 28, 1992

IN 96-48, "Motor-Operated Valve Performance Issues," dated August 21, 1996

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Attachments:

1. Examples of Problems Identified During GL 89-10 Closeout Inspections

ATTACHMENT 1**EXAMPLES OF PROBLEMS IDENTIFIED DURING GI 89-10 CLOSEOUT INSPECTIONS****Thrust and Torque Requirements for Non-Dynamically Tested Motor-Operated Valves (MOVs)**

Some licensees had made general assumptions regarding the reduction in valve factor that were based on increasing valve size, differential pressure, or fluid temperature without sufficient test data to justify these assumptions quantitatively. In addition, some licensees have had difficulty in justifying the capability of certain MOVs that have been sized and set on the basis of unsupported assumptions for thrust or torque requirements. Licensees typically predict the thrust required to operate gate and globe valves from the sum of (1) the product of a valve factor, differential pressure across the valve, and the area of the valve disk; (2) the product of the system pressure and the stem cross-sectional area; and (3) the drag of the valve packing material on the valve stem. Some licensees assumed a generic valve factor of 0.5 (or less) in predicting the thrust required to operate non-dynamically tested gate valves on the basis of their assumption that the selected valve factor was conservative. However, industry and plant-specific gate valve testing has revealed thrust requirements can exceed that predicted by a 0.5 valve factor. Similarly, industry and plant-specific globe valve testing has revealed that a valve factor of 1.1 to predict the thrust requirements might not be adequate for all globe valves. With respect to butterfly valves, industry and plant-specific testing has revealed that vendor calculations might not adequately predict the torque required to operate some butterfly valves. On the basis of industry testing and analyses, the Electric Power Research Institute (EPRI) is revising its application guide for predicting MOV thrust and torque requirements.

Use of Industry Valve Information

Some licensees have found that testing of certain MOVs under dynamic conditions is impracticable and that sufficient test information on similar MOVs at their plants is not available. Consequently, these licensees have obtained MOV performance information from other licensee or industry test programs and the MOV Performance Prediction Methodology (PPM) developed by EPRI. In comparing test data from other sources, it is important to understand the similarity of the valves; test conditions of differential pressure, temperature, and flow; diagnostic equipment and uncertainty; evaluation of the data and any anomalies (such as high static seating loads); and calculation of valve factor (including flow area assumptions). In addition, sufficient data need to be obtained to account for the variability in thrust requirements for similar valves under applicable conditions. EPRI tested a sample of valves of varying manufacture, type and size to validate a bounding methodology for predicting thrust requirements for a wide variety of valves. The NRC staff identified concerns regarding certain specific MOV tests by EPRI during its review of the methodology. These concerns were resolved with respect to the bounding nature of the EPRI methodology in developing the NRC staff safety evaluation.

Some licensees were not addressing the results of the EPRI methodology that predicted potential valve damage and unpredictable thrust requirements for specific valves, and some licensees did not address the

limitations on the applicability of the EPRI methodology (such as limitations due to the specific valve manufacturer).

Justification for Stem Friction Coefficient and Load Sensitive Behavior Assumptions

The efficiency of the conversion of actuator output torque to stem thrust is a function of the stem friction coefficient and the dimensions of the valve stem and its thread. Load sensitive behavior relates to the change in this efficiency when different thrust levels are exerted through the stem. Typically, as the thrust level increases, the stem friction coefficient increases and the thrust delivered at the torque switch trip decreases (referred to as a “rate-of-loading” effect). Some licensees initially assumed a stem friction coefficient of 0.15 (or less) or rate-of-loading effect of 15 percent (or less) and planned to justify these assumptions as part of their dynamic testing under GL 89-10. However, in some cases, insufficient data or higher-than-expected values obtained during the MOV testing caused the staff to question the licensee’s initial assumptions when the data were evaluated in a statistically valid manner. For example, one licensee may have to revise the initial assumption for rate-of-loading effects up to 25 percent. Stem friction coefficient and rate-of-loading effects may vary between MOVs because of factors such as stem lubricant, lubrication frequency, environmental conditions, and manufacturing tolerances of the stem and stem nut. Therefore, it is difficult to apply information on stem friction coefficient and rate-of-loading effects from sources other than the licensee’s testing program. EPRI developed bounding values for load sensitive behavior associated with gate valves as part of its MOV PPM. The NRC staff discusses conditions and limitations of the EPRI methodology in a safety evaluation dated March 15, 1996. Also, some licensees have improperly considered load sensitive behavior (or rate-of-loading effects) to be a random uncertainty, rather than a bias error or a bias/random combination error.

Grouping of MOVs

In GL 89-10, the NRC staff recommended that licensees test their safety-related MOVs under design-basis conditions where practicable. In Supplement 6 to GL 89-10, the NRC staff reiterated that recommendation but provided information on grouping MOVs in situations where a licensee either is not able to test some MOVs under design-basis conditions or chooses not to dynamically test some MOVs. For example, the NRC staff considered it important to (1) assess, when grouping MOVs, such similarities as valve manufacturer, model and size, valve flow, temperature, pressure, installation configuration, valve materials and condition, seat/guide stresses, and performance during testing; (2) test a representative sample of MOVs in each group (nominally 30 percent and no less than 2 MOVs); (3) test each MOV in a group with diagnostics under static conditions; and (4) evaluate any adverse information from individual MOV testing and determine its applicability to the entire group. Some licensees have used approaches for grouping and testing MOVs other than those described in Supplement 6 to GL 89-10. The NRC staff has found that some licensees have not adequately justified testing only one MOV in a group, or a very small sample of MOVs in the group. Also, some licensees have selected a valve factor based on a sample of tests that does not accommodate reasonable variation in the valve factor for other MOVs in the group (for example, the bounds on the valve factor for a group of valves was not always appropriate for the scatter observed in the data). Although some licensees have grouped MOVs in ways that could not be justified, some other licensees have established such a large number of groups (as many as 50) that it is difficult to have sufficient test data for each group. Some licensees have adequately justified including MOVs with small variations in size into the same group in order to minimize the number of groups and allow sufficient data to be obtained for each group.

Degraded Voltage Calculations

The NRC staff discussed in Supplements 1 and 6 to GL 89-10 determination of the voltage assumed at MOVs for design-basis conditions. Various methods are used by licensees to determine the reduction in voltage from the grid to the MOV being evaluated. During GL 89-10 closeout inspections, the NRC staff found that some licensees had not fully justified their assumptions for the grid voltage assumed in their MOV calculations. For example, some licensees assumed full grid voltage as the starting point for calculations, rather than the degraded grid relay setpoint.

Justification for Weak Link Analyses

In Information Notice 96-48, "Motor-Operated Valve Performance Issues," the NRC staff discussed recent failures of MOV keys. Some licensees have also identified cracks in motor shafts for some MOVs. Further, missing bolts or incorrect bolting material has been found in some MOVs. These problems could be related to inadequate justification of the weak link components in MOV analyses. For example, replacement of a motor pinion key with a key of stronger material could cause the weak link to shift to another internal part, such as the motor shaft.

Analytical Evaluation of Potential Pressure Locking of Gate Valves

In Supplement 6 to GL 89-10, the NRC staff provided one acceptable approach for addressing potential pressure locking and thermal binding of MOVs. In GL 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," the NRC staff gave more detailed information and recommendations to address potential pressure locking and thermal binding of gate valves.

During recent GL 89-10 inspections, the NRC staff identified weaknesses in some approaches used by licensees to evaluate the effects of pressure locking of MOVs. Some licensees are relying on analytical approaches (without test-based justification) to provide confidence that the motor actuator can overcome the thrust resulting from pressure locking of its valve. The NRC staff found that some licensees assumed overly optimistic actuator efficiencies in predicting the thrust delivered by the motor actuator under pressure locking conditions. In addition, the staff found that some licensees have insufficient justification for assumptions of significant leakage from the valve bonnet over a short period, and of a very low increase in bonnet pressure with rising temperature.

Evaluation of Test Data

Some licensees have not thoroughly evaluated test data to ensure that the results are reliable. For example, an abnormally low thrust requirement or a back-calculated valve factor might indicate that the design-basis differential pressure and flow were not achieved during the test. Further, anomalies in the data traces could reveal valve or actuator damage. Some licensees have not justified extrapolation of test data based on percentage of design-basis differential pressure and absolute value of differential pressure as discussed in the EPRI MOV program.

Tracking and Trending of MOV Problems

Tracking and trending are important aspects of a licensee's periodic verification program. The NRC staff provided comments on MOV tracking and trending methods in initial reports of GL 89-10 inspections. It also identified weaknesses in the development of MOV tracking and trending methods at some nuclear plants. During GL 89-10 closeout inspections, the NRC staff found that some licensees have not fulfilled their plans to develop MOV tracking and trending methods and that some licensees have highly informal methods without specific guidelines or schedules.

UNITED STATES
NUCLEAR REGULATORY COMMISSION OFFICE
OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

August 1, 2001

**NRC REGULATORY ISSUE SUMMARY 2001-15 PERFORMANCE OF
DC-POWERED MOTOR-OPERATED VALVE ACTUATORS**

ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to inform addressees of the availability of improved industry guidance for predicting the performance of dc-powered motor-operated valve (MOV) actuators. No action or written response is requested.

BACKGROUND INFORMATION

In Generic Letter (GL) 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," the NRC staff requested nuclear power plant licensees to ensure the capability of MOVs in safety-related systems to perform their intended functions by reviewing MOV design bases, verifying MOV switch settings, testing MOVs under design basis conditions where practicable, improving evaluations of MOV failures and corrective actions, and trending MOV problems. Subsequently, in GL 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves," the staff requested licensees to establish a program, or ensure the effectiveness of their current program, to periodically verify that safety-related MOVs continue to be capable of performing their safety functions within the current licensing basis of the facilities. In NRC Information Notice (IN) 96-48, "Motor-Operated Valve Performance Issues," (August 21, 1996) the staff alerted licensees to lessons learned from industry activities to improve MOV performance. All licensees have reported completion of their GL 89-10 programs and are currently implementing their long-term GL 96-05 programs.

As part of their MOV programs, nuclear power plant licensees evaluated the capability of motor actuators to operate their safety-related valves under design basis conditions. In Technical Update 98-01 (May 15, 1998) and Supplement 1 (July 17, 1998), Limitorque Corporation (an actuator manufacturer) provided improved guidance for the prediction of the output capability of its ac-powered MOV motor actuators. On July 24, 1998, the NRC staff issued

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Supplement 1 to IN 96-48 to alert licensees to the updated guidance for predicting ac-powered MOV motor actuator output. In the IN supplement, the staff also stated that the NRC Office of Nuclear Regulatory Research was sponsoring a study of the performance of dc-powered MOV actuators at Idaho National Engineering and Environmental Laboratory (INEEL). The results of the study are provided in NUREG/CR-6620, "Testing of dc-Powered Actuators for MotorOperated Valves" (May

1999). In the tests documented in that study, the performance of certain Limitorque dc-powered motor actuators raised concerns about industry guidance for predicting the performance of dc-powered MOV actuators. For example, the effects of high ambient temperature in reducing the output torque of the motor were more significant than predicted. The adequacy of a linear relationship in evaluating the effects of reduced voltage supplied to the motor depended on considering reduced speed, increased temperature, and reduced output torque. The stroke time of some dc-powered MOVs increased significantly under loaded conditions. For some tested motor actuators, the efficiency of the actuator gearbox in converting input motor torque to output torque at the valve stem fell below the published “pullout” efficiency at low operating speeds and high loads.

SAFETY SIGNIFICANCE OF ISSUE

Many fluid systems at nuclear power plants depend on the successful operation of MOVs in performing their system safety functions. Safety-related MOVs must be capable of operating under design basis conditions, which may include significant differential pressure across the valves and high fluid flow, high ambient temperature, and degraded motor voltage. Operating experience at nuclear power plants in the 1980s and 1990s revealed weaknesses in many activities associated with MOV performance. These weaknesses reflected potential common-cause failure mechanisms as a result of which multiple safety-related MOVs could become incapable of performing their safety functions under design basis conditions. In light of the weaknesses, the NRC staff issued GL 89-10 and subsequently GL 96-05 to request that licensees verify initially and periodically the design basis capability of safety-related MOVs. Since then, the industry has expended significant resources to resolve deficiencies in MOV performance identified during implementation of the GL 89-10 and GL 96-05 programs. Adequate MOV actuator output capability is one issue that the industry is addressing as part of its response to GL 89-10 and GL 96-05. In this effort, the industry has implemented improvements in its methods of predicting the performance of ac-powered MOVs. The industry is now improving the guidance for predicting the performance of the less common dc-powered MOVs. As a result of weaknesses identified in the prediction of motor-actuator performance, dc-powered MOVs could become incapable of performing their safety functions under design basis conditions.

INDUSTRY RESPONSE

In response to the concerns raised in NUREG/CR-6620, the Boiling Water Reactor Owners' Group (BWROG) prepared Topical Report NEDC-32958, Revision 0, “BWR Owners' Group DC Motor Performance Methodology - Predicting Capability and Stroke Time in DC Motor-Operated Valves” (March 2000). BWROG assumed the lead among the nuclear plant owners groups in addressing this issue because dc-powered MOVs are applied more often in boiling water reactors (BWRs) than in pressurized water reactors (PWRs). On August 30, 2000, the NRC staff held a public meeting to discuss the BWROG methodology for predicting dc-powered MOV performance. The BWROG methodology calculates (1) the required thrust to operate the valve (2) motor torque, current, voltage, speed, and heatup and (3) gearbox efficiency, at each position of the valve stroke. With this information, the BWROG methodology determines (1) the capability margin of the MOV actuator (2) the maximum allowable thrust setting at the torque switch trip position and under unwedging conditions and (3) the stroke time of the valve. BWROG used vendor motor performance curves and

test data from the INEEL study and industry sources in developing the methodology. BWROG compared its methodology predictions to test data from in-plant flow tests for seven MOVs under various conditions, and found the results to be acceptable. BWROG is cooperating with the other owners groups regarding the availability of the methodology. In a letter dated October 2, 2000, BWROG recommended an implementation schedule of 12 months or the first refueling outage (whichever is later) for first-priority MOVs and two refueling outages for second-priority MOVs. As defined by BWROG, first-priority MOVs are dc-powered MOVs that have a static test frequency of two cycles or less in the industry-wide Joint Owners Group Program on MOV Periodic Verification in response to GL 96-05. Second-priority MOVs are the remaining dc-powered MOVs in the GL 96-05 program. In its letter, BWROG noted that the start date for the implementation schedule is defined as the date on which the NRC acknowledges that the BWROG methodology is acceptable through a RIS or another regulatory document.

SUMMARY OF THE ISSUE

The weaknesses identified in NUREG/CR-6620 regarding the prediction of dc-powered MOV actuator performance could prevent dc-powered MOVs from performing their safety functions under design basis conditions. In support of its evaluation of the industry response to this issue, the NRC staff has reviewed the new BWROG methodology for predicting the performance of dc-powered MOVs. As part of ongoing NRC-sponsored research, INEEL predicted the performance of a sample of dc-powered MOV actuators included in the development of the BWROG methodology, using an independent model developed at INEEL. The staff notes that the BWROG methodology used best available information for some aspects of dc-powered MOV performance that could be refined in the future. Based on its sample review, the staff considers the BWROG methodology to represent a reasonable approach in the improvement of past industry guidance for predicting the stroke time and output of dc-powered MOV actuators. The staff considers the BWROG methodology to be applicable to BWRs and PWRs because of the similarity in the design and application of dc-powered MOVs used in nuclear plants. In reviewing MOV programs established in response to GL 96-05, the staff has discussed with licensees the prediction of the performance of dc-powered MOVs, and verified that licensees are aware of the BWROG initiative. The staff also discussed the ongoing efforts regarding dc-powered MOV output performance in safety evaluations prepared to close the reviews of GL 96-05 programs at individual nuclear plants. Now that the new BWROG methodology is available to licensees, the NRC staff considers the regulatory issue of the adequate prediction of the performance of safety-related dc-powered

MOV actuators can be effectively resolved through implementation of improved industry guidance.

The staff will continue to monitor long-term periodic verification programs for MOVs (including dc-powered MOV actuators) being implemented by licensees in response to GL 96-05 at nuclear power plants.

BACKFIT DISCUSSION

This RIS requires no action or written response and is, therefore, not a backfit under 10 CFR 50.109. Consequently, the NRC staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment was not published in the *Federal Register* because this RIS is informational.

PAPERWORK REDUCTION ACT STATEMENT This

RIS does not request any information collection.

Please refer questions about this RIS to the technical contact identified below.

/RA Frank P. Gillespie Acting for/ David B. Matthews,
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**LIST OF RECENTLY ISSUED
NRC REGULATORY ISSUE SUMMARIES**

Regulatory Issue		Date of	
Summary No.	Subject	Issuance	Issued to
2001-14	Position on Reportability (BWR) Requirements for Reactor Core Isolation Cooling System Failure	07/19/2001	All holders of boiling-water operating licenses
2001-13	10 CFR Part Exemptions for Uranium Contained in Aircraft Counterweights	2001-10	Revisions to Staff Guidance on Notices of Enforcement Discretion
2001-12	Nonconservatism in Pressurized Water Reactor Spent Fuel Storage Pool Reactivity Equivalencing Calculations	2001-09	Control of Hazard Barriers
2001-11	Voluntary Submission of Performance Indicator Data		

07/20/2001 All holders of licenses authorized to manufacture aircraft counterweights containing uranium, and organizations and end users who may possess such counterweights

05/11/2001 All holders of operating licenses for pressurized water reactors

05/18/2001 All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have

tor vessel

certified that fuel has been permanently removed from the reactor vessel

04/02/2001 All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel

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OL = Operating License CP = Construction Permit